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of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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PROCEEEDINGS

of the

Forty-Eighth Annual Meeting

of the

American Fisheries Society

NEW YORK CITY

September 9, 10 and 11, 1918

Opening Session, Morning, September 9, 1918.

The Forty-eighth Annual Meeting of the American Fisheries Society was convened in New York City, in the Waldorf-Astoria Hotel, on the morning of September 9, 1918. Mr. Henry O'Malley, the President of the Society, presided throughout the various sessions.

The members present were requested to register. Fifty-four members were present at the opening session and twenty-six registered later, making a total of eighty-one members present during the meeting. Twenty-four States, the District of Columbia, Canada and China were represented.

President O'Malley appointed the following Committees:

Committee on Nominations: Messrs. Henry B. Ward, Geo. H. Graham, A. H. Dinsmore, Eben W. Cobb and S. M. Cowden.

Committee on Time and Place of Meeting: Messrs. John P. Woods, T. Roualt, Geo. D. Pratt, Grant E. Winchester and John M. Crampton.

Program Committee: Geo. C. Embody, Adrian Thomas and Carlos Avery.

Auditing Committee: Messrs. John P. Woods, Geo. H. Graham and Jas. Nevin.

Committee on Resolutions: Messrs. M. L. Alexander, A. J. Crandall and John R. Woods.

Committee on Awards: Messrs. John W. Titcomb, Henry B. Ward, G. E. Jennings, A. L. Millett, J. G. Needham and G. C. Leach.

The Secretary, Mr. John W. Titcomb, presented the names of applicants for membership, who were then admitted by vote of the Society. The names of these new members have already been published as an appendix to the List of Members, TRANSACTIONS, Sept., 1918, p. 135).

Mr. A. L. Millett, Treasurer of the Society, reported that he had attended the annual meeting of the Canadian Fisheries Society at Halifax, a couple of weeks previously, and that he was much impressed with the fine character of the meeting and the high quality of the program. He brought with him the greetings and best wishes of the Canadian Society.

Following a number of announcements by the Secretary, the meeting adjourned early in order to allow the various committees ample time for their work.

Monday Afternoon Session, September 9th.

The Session was devoted to the reading and discussion of papers.

Results of Some Trout Feeding Experiments carried on in the Experimental Hatching Station of Cornell University.

BY DR. GEO. C. EMBODY.

This paper, which was given first place in competition among the papers on fish culture, has already been published (TRANSACTIONS, Dec., 1918, p. 26).

Discussion.

In the discussion which followed the reading, Professor Embody replied to a number of brief questions, explaining that the temperature (Fahrenheit) ranged from about 65° down to about 37°. In most of the experiments the

temperature ranged from 55° to 65°. The experiments were made at all times of the year, but most of them were made during the summer months. Ordinary pure spring water was used, without filtration, as it came directly from a spring.

MR. JAS. NEVIN, of Wisconsin: We have found horse meat much superior to any other for our brook trout. At one hatchery we are using sheep liver and find it very good food, provided that Red Dog Flour is boiled and mixed with it. But I find that the greatest success in fish culture is in connection with the water. In some of our hatcheries we have success with some kinds of fishes and not with others. We have one hatchery where we will run about sixty-five per cent of losses with pike-perch eggs, while in another we hatch 90% to 95% of them.

MR. JOHN W. TITCOMB, of New York: Dr. Embody's paper is a most valuable and timely contribution, because the cost of food in these days is a very serious one. In addition to the cost value of the fish foods, Dr. Embody's experiments have in mind the effect upon the quality of the flesh, which is very important, but in the production of fingerlings for distribution the food that will produce results at minimum cost, taking into consideration both labor and material, is the one which will be most generally adopted. Assuming that the fish which are planted as fingerlings will thereafter depend entirely upon natural food, the quality of the flesh will be adjusted by the time the fish have grown to edible size.

Since knowledge of negative results of experiments may prevent waste of energy through repetition, I will briefly review some experiments at the State Fish Hatchery at Caledonia, New York.

The experiments were under the immediate supervision of Mr. Thomas Chamberlain, a student of Dr. Embody, operating under my direction. One of the objects of the experiments was to apply in a practical manner, in regulation rearing ponds, the knowledge obtained from the experiments in the small and limited number of rearing boxes available at Cornell University and to supplement them with other experiments suggested by hatching customs and conditions.

The experiments were terminated rather abruptly when Mr. Chamberlain was drafted into the army, where he is now patriotically serving his country "over there."

For some of the experiments concrete rearing pools 3 feet by 36 feet to the number of ten were utilized. For other experiments, hatching troughs 14 inches by 12 feet were used. The species fed under observation consisted of brook trout, lake trout and rainbow trout and the following tables give the results. (The tables are a condensation of a portion of Mr. Titcomb's remarks).

TABLE No, 1.

October 27, 1917—February 7, 1918. (Period of 103 days, minus 7.*)	RAINBOW TROUT YEARLINGS.				
Food used	75% melts 25% meat meal	75% lungs 25% meat meal	75% liver 25% meat meal	50% lungs 50% melts	50% liver 50% melts
Size of basin	36′x3′x10″	36′x3′x10″	36′x3′x10″	36′x3′x10″	36′x3′x10″
Number of fish:					
Beginning of period	406	406	406	406	406
End of period	406	406	404	405	405
Total mortality	0	0	2	1	1
Total weight of fish:					
Beginning of period	30 lb., 7 oz.	34 lb., 3 oz.	31 lb., 7 oz.	36 lb., 1 oz.	32 lb., 4 oz.
End of period	46 lb., 3 oz.	39 lb.,12 oz.	49 lb., 9 oz.	36 lb.,10 oz.	42 lb., 4 oz.
Total gain or loss	15 lb.,12 oz.	5 lb., 9 oz.	18 lb., 2 oz.	9 oz.	10 lb.
Average individual weight:					
Beginning of period	1.199 oz.	1.347 oz.	1.238 oz.	1.421 oz.	1.271 oz.
End of period	1.820 oz.	1.559 oz.	1 938 oz.	1.447 oz.	1.694 oz.
Average individual gain or loss	.621 oz.	.212 oz.	.700 oz.	.026 oz.	.423 oz.
Approximate average water temp	44.75° F.	44.75° F.	44.75° F.	44.75° F.	44.75° F.
Weight of food daily consumed	First period, 1 lb. Second and third periods, 10 oz.				
Total weight of food consumed	68 lb.,10 oz.	68 lb.,10 oz.	68 lb.,10 oz.	68 lb.,10 oz.	68 lb.,10 oz.
Average food consumed per individual	3.197 oz.	3.197 oz.	3.205 oz.	3.201 oz.	3.201 oz.
Average number of individuals	406	406	405	405.5	405.5
Total efficiency factor = total gain / total consumption	.229	.081	.262	.008	.145
Individual efficiency factor = average individual gain / average individual consumption	.194	.166	.218	.009	.132
Cost per pound of food	$.0425	$.0725	$.095	$.06	$.075
Cost per pound of increased weight of fish	$.185	$.887	$.351	$.732	$.515

* On four days no meat received at hatchery. On three days it was impossible for Mr. Chamberlain to make observation.

TABLE No. 2

Period of 14 Days. Oct. 25—Nov. 8, 1917.	Lake Trout Fing.		Brook Trout Fing.		Rainbow Trout Fing.	
Food used	75% milk 25% meat meal	50% liver 50% melts	75% milk 25% meat meal	50% liver 50% melts	75% milk 25% meat meal	50% liver 50% melts
Size of basin	12'x3'x10"	12'x3'x10"	12'x3'x10"	12'x3'x10"	12'x3'x10"	12'x3'x10"
Number of fish:						
Beginning of period	2,206	2,354	749	609	979	949
End of period	2,182	2,344	718	608	979	949
Total mortality	24	10	31	1	0	0
Per cent mortality	1.09%	.42%	4.32%	.16%	0	0
Total weight of fish:						
Beginning of period	13 lb., 1 oz.	16 lb., 7 oz.	5 lb.,8.5 oz.	5 lb.,11 oz.	4 lb., 9 oz.	4 lb., 9 oz.
End of period	12 lb.,11.5oz	17 lb.,13 oz.	6 lb.,6.5 oz.	6 lb.,12 oz.	5 lb., 2.5 oz.	5 lb., 4 oz.
Average individual weight:						
Beginning of period	.094 oz.	.112 oz.	.118 oz.	.149 oz.	.074 oz.	.079 oz.
End of period	.093 oz.	.121 oz.	.143 oz.	.177 oz.	.084 oz.	.089 oz.
Av. individual gain or loss	—.001 oz.	.008 oz.	.025 oz.	.028 oz.	.010 oz.	.010 oz.
Approximate average water temp	47° F.	=ditto	=ditto	=ditto	=ditto	=ditto
Wt. of food daily consumed	11 lb., 4 oz.	11 lb., 4 oz.	10 oz.	10 oz.	10 oz.	10 oz.
Wt. of total food consumed	171 lb.,8 oz.	171 lb.,8 oz.	81 lb.,12 oz.	81 lb.,12 oz.	81 lb.,12 oz.	81 lb.,12 oz.
Average food consumed per individual	.128 oz.	.119 oz.	.190 oz.	.230 oz.	.145 oz.	.148 oz.
Av. number of individuals	2,194	2,349	733.5	608.5	979	949
Total efficiency factor = total gain / total consumption	—.020	.079	.100	.121	.069	.079
Individual efficiency factor = average individual gain / average individual consumption	—.078	.075	.132	.122	.068	.068
Cost per pound of food	$.05	$.0725	$.05	$.0725	$.05	$.0725
Cost of each pound of increased weight of fish	.....	$.92	$.50	$.60	$.74	$.63

TABLE No. 3

Nov. 8—Nov. 28, 1917. (Period of 20 days).	Lake Trout Fing.		Brook Trout Fing.		Rainbow Trout Fing.	
Food used	75% milk 25% meat meal	50% melts 50% liver	75% milk 25% meat meal	50% melts 50% liver	75% milk 25% meat meal	50% melts 50% liver
Size of basin	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″
Number of fish:						
Beginning of period	2,182	2,344	718	608	979	949
End of period	2,166	2,340	671	603	979	949
Total mortality	16	4	47	5	0	0
Total weight of fish:						
Beginning of period	12 lb.11.5 oz.	17 lb.,13 oz.	6 lb.,6.5 oz.	6 lb.,12 oz.	5 lb.,2.5 oz.	5 lb., 4 oz.
End of period	14 lb.,5.5 oz	19 lb.14.5 oz.	61 lb.,11 oz.	81 lb.,10 oz.	5 lb., 6.5 oz.	5 lb.,14.5 oz
Total gain or loss	1 lb.,10 oz.	2 lb., 1.5 oz.	5.5 oz.	1 lb., 14 oz.	4 oz.	10.5 oz.
Average individual weight:						
Beginning of period	.093 oz.	.121 oz.	.143 oz.	.177 oz.	.084 oz.	.089 oz.
End of period	.106 oz.	.148 oz.	.159 oz.	.228 oz.	.088 oz.	.099 oz.
Av. individual gain or loss	.013 oz.	.027 oz.	.016 oz.	.051 oz.	.004 oz.	.010 oz.
Approximate average water temperature	46° F.	=ditto	=ditto	=ditto	=ditto	=ditto
Wt. of food consumed daily	1 lb., 4 oz.	1 lb., 4 oz.	10 oz.	10 oz.	10 oz.	10 oz.
Total food consumed	25 lb.	25 lb.	12 lb., 8 oz.	12 lb., 8 oz.	12 lb., 8 oz.	12 lb., 8 oz.
Average food consumed per individual	.184 oz.	.170 oz.	.289 oz.	.330 oz.	.204 oz.	.211 oz.
Av. number of individuals	2,174	2,342	694.5	605.5	979	949
Total efficiency factor= Total gain / Total consumption	.065	.084	.028	.150	.020	.053
Individual efficiency factor= Average individual gain / Average individual consumption	.071	.159	.055	.155	.019	.047
Cost per pound of food	$.05	$.075	$.05	$.075	$.05	$.075
Cost per pound of increased weight of fish	$.769	$.89	$1.81	$.50	$2.50	$1.43

It will be seen that milk thickened with rennet or junket proved of no value as a fish food, notwithstanding the fact that Dr. Embody, in earlier experiments, had succeeded in rearing to fingerlings some rainbow trout fed entirely upon thickened skim milk. The milk experiment had in contemplation the use of a by-product from the creameries. While the results of the milk experiment at Caledonia are regarded as final, the success in another water supply confirms some views I have entertained that an artificial fish food which is entirely satisfactory in water from one source of supply may be quite the reverse in water from another source. It suggests some ramifications of this subject too extensive for discussion now.

These are crude experiments. We did not weigh all of the fish in each instance, but we took a certain number of fish each time at random instead of taking the total number under observation, which would be rather difficult in an experiment on so large a scale. I hope Dr. Embody will continue this work. I think it means a great deal.

Now may I talk on the general subject of fish food, because perhaps some of the suggestions will help others? The war just about doubled the cost of fish food, as you know, and we had to resort to every possible makeshift to raise fingerlings in increased numbers and still keep within a legislative appropriation based upon pre-war prices. Where we were using beef liver we changed to pig liver or to melts—very largely to melts. At the Chautauqua Hatchery, where we operated nets for taking the muscallunge and kept the nets set for removing the bill fish or gar pike, we caught a great many carp. The foreman raised some beautiful four inch fingerling trout by feeding carp. The fish were about one and a half inches in length when Mr. Winchester began feeding them carp. Foreman Winchester's recipe for preparing the carp and suckers for fish food is as follows:

"Hang them up, hooked in the mouth; cut around gills, down the back, and on each side of the stomach. Pull the skin off with pincers. Then strip the meat off the backbone and ribs and run it through The Enterprise meat chopper."

Near the Adirondack Hatchery there are lakes containing yellow perch which, during the summer months, are grubby and the people don't care for them. To get them out of the lake is a good thing. Foreman Otis caught grubby yellow perch and fed them to the fingerling trout, and it proved to be a very desirable food. The perch are skinned and then ground up in a meat chopper, guts and all. At the Fulton Chain Hatchery a good many suckers were used to feed the trout, after preparing them in a similar manner. These perch and suckers are not of much value in the summer time as human food. One might argue that carp is a human food, and I will confess to you that if we had to buy the carp at 12 cents a pound, which is the wholesale price, and then allow for the waste, it would be a very expensive food, but the carp are undesirable in the lake where caught.

Another year it is proposed to "beat the devil around the stump" by letting some of the carp go to human consumption as war food, and arrange with the man who markets them to furnish us liver or melts in exchange,

but I want to say that as far as my experience has gone it is a mighty good thing to use fish to some extent as fish food. With a part fish diet you get a better quality of fish and a stronger fish than if you feed entirely on liver and melts.

MR. G. C. LEACH, of the U. S. Bureau of Fisheries: I notice nothing has been said in the discussions about beef heart. In the middle west, beef heart usually sells for twenty to thirty per cent cheaper than beef liver, and it has been considered that in protein content it is fifty per cent greater than beef liver. In making up contracts with the packing houses, if it is specified that they must trim the beef liver of all gristle and fat, the fish culturist does not have much to eliminate, and that part that he does have to cut out can be fed to the adult fish. All the better portion of it can be passed through the meat grinder several times, using a very fine plate, and fed to the fry. I have found that it is preferable to the beef liver, because the liver, when ground very fine, disintegrates into a liquid and a fibrous substance, either of which may cause mortality in the trout. The beef heart grinds in very fine particles and the fry get something that does them some good; so, for that reason, out in the middle west we have been feeding beef heart when we could get it, and it has always given very good satisfaction.

In the middle west, also, we feed to our larger fish various gross fish, such as the gissard shad, and cat-fish, perhaps a little off the mark, and purchased for about six cents a pound. That diet is very good for adult fish, but when ground through the smaller plates it disintegrates and I doubt if it is very good for small fish unless fed with some carbo-hydrate. But for the larger fish I believe it produces a better egg and is more of a natural fish food, especially for trout.

PROFESSOR E. E. PRINCE, of Ottawa, Canada: I think it is desirable in selecting food always to look at the character of the natural food of the fish. The trout are great insect feeders in the fresh water, and anything that corresponds to the physical character of this insect food ought to be good. Ground up shrimps of course would correspond to the food they get in the salt water. Fish itself would correspond to the various species of fish on which trout and salmon no doubt live to some extent in fresh water, but I have always felt that the large internal organs of mammals, like liver, lungs, etc., do not quite correspond to anything in the natural food of these fish, and therefore it would be wise to combine other elements with this ground lung and liver in order to provide a concentrated food.

There is no doubt that fish fed with very concentrated food are apt to have digestive troubles. The digestive canal is prepared to deal with a certain amount of waste, and if there is no waste to the food, indigestion is apt to occur. Consequently, it is a good thing to put in more fresh material along with the fish, or shrimp powder, or whatever it may be, in order to give the intestines some work to do.

You may have noticed in the Canadian reports that coarse fish ground up was used, years ago, for feeding the young fingerling salmon, and it was

a great success. The ground up meat of these suckers and inferior fish is not cooked. I have sometimes thought the cooking of meats changed them to such an extent that perhaps it made a difficulty in digestion for young fish. If we could provide them with materials which are uncooked, perhaps we may have better results. A good food must have waste materials in it in order to avoid digestive troubles.

I look forward with much interest to the further work which Dr. Embody promises to carry on, because I feel this is one of the fields in which very valuable results are to be achieved, and I should like to hear what the results of using fish roes, ground shrimps, etc., may be, where those are obtainable.

MR. GEO. H. GRAHAM, of Massachusetts: During the past two years there has been more fault found with eggs that come from the commercial hatcheries because of infertility or the young fish dying soon after hatching, it seems to me, than any period I have ever heard of. Some of the largest commercial hatcheries have been putting out bad eggs, which show very poor success at the different hatcheries, and we also know that during the past two years some of the commercial hatcheries have had a great mortality among the young fish. Now is it not possible that this trouble may all be due to the fact they have been feeding the wrong stuff? If they are feeding fish entirely to their adult trout, we may suppose that those fish are not capable of producing eggs with any vitality to them, and it would seem to me that if Dr. Embody could find out what they have been feeding in the last two years to their adult fish, it might give him some clue as to what not to feed. Of course, they have been doing this on account of the high cost of liver, which they have previously fed, and in trying to obtain a substitute they have possibly been using the wrong food.

MR. G. C. LEACH: I would like to ask Dr. Embody why he eliminated beef heart in his experiments, and if he expects to do anything with regard to that in the future?

DR. EMBODY: We have not eliminated beef heart. We have not gotten around to it yet. I hope in time to try all of these foods, including the dry meats.

THE SECRETARY, MR. TITCOMB: I do think the food has a great deal to do with the quality of the eggs. Mr. Walters, of the Cold Spring Harbor Hatchery, tells me that when he raised some trout and fed them on mussels—he is right near the shore—he could not get good eggs from trout fed on salt water mussels. I am not entirely satisfied, and he has asked me to try it again some time.

We have had this same trouble with the commercial eggs this year, and have been hoping to get more wild eggs and see what the difference is. It was not a fair year for comparison. It was a very unusual season for taking eggs and for shipping them, and I am not prepared to say whether the trouble was with barren fish, or partly due to complications in transportation. The eggs would be on the road a month instead of three days. When received, the foreman would report them frost-bitten or frozen. We had one case

shipped from Pennsylvania which wandered around the country for a month and finally reached the hatchery from which it was shipped without any tags on and with the eggs all frozen.

I wish you would all consider this point. We distribute eggs from various commercial dealers to all of the hatcheries which handle trout. We buy from as many commercial dealers as we can get reasonable prices from and feel sure that the eggs are good. We keep a record of the eggs from year to year. In other words, we rate each dealer as to the percentage of hatch. Each foreman reports the results from the loss of eggs received from half a dozen different dealers, for illustration, and then we know that if all of the foremen report a bad hatch of eggs from any one dealer, the fault must be with the barren fish, or with the method of handling at the original source and we drop that dealer from our lists. We try to deal with men whose eggs generally rank well at all of the hatcheries. We may find that there is a poor percentage of hatch at one hatchery, while the majority of the hatcheries give a good percentage. We then presume there was some fault in transportation, or in water at the hatchery, or in methods of hatching, and we give that dealer an opportunity to try again. If we who buy eggs throughout the country of almost all the same dealers, could compare notes, we might get some material which would be the basis for further investigations for the food which is fed the fish at the source of supply.

In regard to water supply, I want to say here what I say every chance I get, that you, who have the locating of hatcheries under your control, should test the water for eggs and young fish for at least a year before you invest the people's money in those hatcheries, and that if any political influence to locate a hatchery is brought to bear, you withhold your action until you have made that test, because you can save the people a great deal of money. You all know it. I do not have to go into detail either for the Bureau of Fisheries or any of the States.

MR. NEVIN, of Wisconsin: I wish to say, gentlemen, that in one of our hatcheries I have just the condition that Mr. Titcomb spoke of. The fish are most prolific, and the eggs which were hatched there are sent to our other hatcheries, where they do excellently, but at home in their own water they do nothing. We cannot keep them until they are six weeks old.

Studies on the Nutrition of Fish: Experiments on Brook Trout.

BY DR. SERGIUS MORGULIS.

(Read by Prof. Henry B. Ward).

This paper was awarded first place in the class of papers dealing with biological investigation of fish and fisheries problems. It has already been published (TRANSACTIONS, Dec., 1918, p. 34).

Discussion.

THE SECRETARY, MR. TITCOMB: This paper represents a tremendous amount of work, and it gives you just an inkling of what it means to come

face to face with the fish food situation. Some commercial hatcheries are boiling midlings and putting them in half and half to feed the fish. We have always wondered how much of that grain was digested by the fish. The paper goes right hand in hand with Dr. Embody's, but it shows what termendous difficulties one is under in keeping up with that side of the problem. We cannot get at it the way we can with terrestrial animals. But if this beginning made by Dr. Morgulis will lead to something, it means a good deal, because we never know fully the value of different foods we are trying until we know how much of those foods are assimilated by the fish we are feeding.

DR. GEO. C. EMBODY, of Cornell University: I have been exceedingly interested by this paper. It is possible to reduce some of Dr. Morgulis' results to the same category as mine. For instance, what he calls the index is exactly the same as what I call the reciprocal efficiency factor, that is, one divided by the amount of food necessary to produce one pound of trout. Now you will recall that in the case of millings, I secured a cost production of one pound of trout at thirty-seven cents. The averages of his three experiments with raw beef hearts makes a direct efficiency factor of 2.15, and if hearts cost ten cents a pound, that means it costs only 21 cents a pound to produce the trout, twenty-one cents compared to thirty-seven in the case of liver—a distinct saving.

The paper furnishes us data for solving some problems that we have been wanting to solve for a long time. It shows a way for determining the correct nutritive ratio between the amount of protein and carbo-hydrate, a ratio which has been known for a number of years in the case of domestic animals. The difficulty of finding it in the case of trout is due to the fact that the nitrogen not only passes out by means of the feces, but through the urine. There is no way of separating the urine from the feces, and consequently no way of separating the nitrogen of the urine from the nitrogen of the feces, which must be done before one can determine with any degree of accuracy the correct nutritive ratio of these products with reference to trout. I think this paper goes a long ways towards the solution of that one problem, and will be exceedingly valuable for that as well as for many other reasons.

DR. HENRY B. WARD, of Illinois University: The paper is exceedingly difficult to grasp thoroughly when one reads it. It must be more so than when one sees it in print, because of the wealth of minute data of extreme accuracy, which goes to safeguard the general results. But I am sure there are some things which Dr. Morgulis would want to have indicated lest improper conclusions be drawn from the statements in the paper.

Now, as we know from feeding experiments with other animals, each kind of food must be tested by itself, and to determine that these foods, when cooked with the liver or beef hearts, are not as efficient as the same food uncooked, does not prove that the same holds true of all kinds of food uncooked.

If I remember correctly, Mr. Titcomb referred to the habit of certain persons cooking mixed foods containing a certain amount of plant material or grains. You will, many of you, who have attended these meetings for some years, recall the experiments of our dear friend, Professor Dyche, of Kansas, in raising fish on grain in the experimental fish ponds of that state. Now it is a very fair question to ask whether, if you were to attempt to utilize a food of the solid type of grain, or of the condensed sort of vegetable foods, some cooking is not necessary in order to make it possible for the fish to utilize it, and whether the lack of utilization found in some experiments, is not due to the lack of mere softening to put the food in such condition that the digestive processes can be carried out and the material utilized. You see the experiments there differ very radically from those on which Professor Morgulis was engaged.

The ultimate question in future will have two elements also, first, its degree of utilization, which Professor Morgulis has treated here quite carefully for individual foods; and, second, its cost. If half as much of one food is utilized, and that food would only cost one-third as much, it still might be the better food to use. The question of the degree of utilization once for all concludes the problem for the fish culturists of what kind of food should be used in practical work.

And then there is a third question, and that is the effect of mixed diet, for we know very well by animal experimentation in other cases that feeding with a single food substance and feeding with a mixture of food materials, are accompanied by quite different relative results, and the amount of material utilized in a mixture may be quite different from the amount of some material which is used and results obtained in feeding with a single type of food. This concerns not merely different kinds of animal food, but also a mixture of animal plant food, and Prof. Embody had some very interesting suggestions concerning a mixture of different kinds of animal food. Of course I mention that here, not to contribute anything to the knowledge of the subject, but perhaps to keep some of you from drawing indirect conclusions from this or some other paper. Feeding with a single substance will show one element in the problem. It will not decide, however, the relative advantage of that substance over any other single substance, until the mixture has been tested. Until the question of mixtures as different as those of animal and plant food be tested, and until the question of cooking be tested on plant material, and all of these tests averaged with the cost, the man who wants to feed his trout cannot tell finally what is the most efficient food, that is, the food which can be fed at the least cost, and the best results secured.

A Study of the Effects of Certain Oils, Tars and Creosotes Upon Brook Trout (Salvelinus Fontinalis).

BY ADRIAN THOMAS.

This paper, with the discussion, appears later in this issue of the TRANSACTIONS, page 121.

President O'Malley then introduced Dr. F. T. Sun, President of the Fisheries School of Tientsin, China.

DR. SUN'S ADDRESS.

Mr. President and Gentlemen of the Society:

It is a great honor and pleasure for me to be present today and to have the opportunity of meeting your scientific and practical fisheries men assembled here in this convention of the American Fisheries Society. It had been my original intention during my study of the fisheries of this country to permit myself the pleasure of a call upon some of you gentlemen in your various home cities, and to secure from you such information as you would be good enough to give me. I discussed my proposed itinerary with Dr. Hugh M. Smith, head of the Bureau of Fisheries in Washington, D. C., and asked him just how I could manage all this, and he suggested that it might be advisable for me to come to this meeting in order that I might here have an opportunity to meet all of you together and secure the valuable information which is bound to result from a meeting of this kind.

In China, as you doubtless know, we have various provinces stretching all along the coast. In addition, there are about fifteen provinces in the interior of the country. The coastal fisheries are inadequate to furnish sufficient fish for the interior provinces. On account of the difficulties of transportation, particularly, it is difficult for us to send salt water fish to remote provinces and as a result the price of the salt water fish is much higher than for those of the fresh water rivers and lakes. The Chinese seem to be very much more appreciative of the fresh water fishes, also, than of those caught from the salt waters.

We have some recent literature dealing with fish and fisheries in China, but for the most part our fish culturists and fishermen are working in their various sections according to information published in books that were prepared in the time of our forefathers.

More than ten years ago I proposed to our government the advisability of encouraging some of the more up to date leaders of fish culture in China. I suggested also that we strive to co-ordinate the scientific and practical work incident to our fisheries. We have found it to be somewhat difficult to get our practical fishermen to adopt the views of our scientific culturists.

Sometimes our practical men have thought they knew much more about such matters than our scientific men.

Also, it was a part of our newer ideas to establish fish aquaria and museums, and to establish schools or courses in schools that would teach practical and scientific methods concerning our fisheries. Ten and a half years ago our first school was established in Tientsin, China, and shortly afterwards schools were organized in three other cities, two of them in the southern part of China and one in the northern part. It is our earnest hope that we may shortly establish more schools in various provinces and in various parts of the several provinces—not only schools, but industrial institutes to teach the industrial and commercial work incident to fisheries. It is a part of the work of these schools to instruct the children along commercial lines with reference to fisheries, such as the manufacturing end of the business, the proper methods for sorting, smoking and canning fish, the construction of nets and all things which are in any way connected with fisheries. These studies were introduced very successfully among the young Chinese students. Sometimes the professors of a school will take their students in a body to various provinces and there will be an interchange of ideas and of information and thus we are able to spread the new methods of fish culture, manufacturing, etc. Splendid results have been noticeable in a very short time.

I thought, however, that I ought to secure information from countries other than our own and ascertain the best methods in use in various countries for fish culture and the practical side of fisheries, manufacturing, canning, etc.

We are making progress with our fisheries literature, and, in addition to the Chinese books which have been handed down by our forefathers dealing with this question, we have already translated a number of books from the English and have introduced books from the United States and from Japan. But some of our literature I consider rather out of date. So many new questions are coming up all the time and so many new methods and plans are being devised that, when I had the opportunity, I felt it to be incumbent upon me to come to this country and spend about four months visiting various states and examining the hatcheries in various points, and studying the question with the

fish experts in Chicago, Washington, Boston, Gloucester and other cities. I have secured much valuable information from the professors in your schools and from your commissioners along the line of fisheries, both as regards the industrial and scientific questions involved, as well as with reference to the food situation. Altogether, I shall have spent six months in this country. Everywhere I have gone I have received helpful information. You have made a great progress with this work in your country and it is known all over the world.

I have had the temerity to suggest in various places that you establish courses with reference to fish culture in your various universities and I have agreed to send photographs and information concerning what we are doing to those of you in this country who are interested. I hope that we may have the pleasure of communicating with each other in the future frequently and of exchanging information and ideas and I can assure you I shall always be glad to have you mail me any of your publications with regard to fish culture. In return I should be very glad indeed to submit to you any of our publications, only I am sorry they would be printed in Chinese characters and might be a little difficult to read.

In addition, as the world is small these days, I hope that it may be your opportunity in the near future to make a trip to the Orient, perhaps after the war, in order that you may study some of the conditions in China. I shall be very glad indeed to welcome you at any time.

President O'Malley replied briefly to Dr. Sun, thanking him for his address and assuring him of the honor the Society felt in his presence at the meeting.

The Chairman of the Committee on Resolutions, Mr. M. L. Alexander, presented the following resolution:

> As an evidence of the loyalty of this body, the Committee on Resolutions has decided to ask the Society that they remit the dues of all members who are now in the service of our government and that this resolution be passed upon immediately.

The motion was seconded by Mr. John W. Titcomb and passed unanimously.

The session was adjourned.

Tuesday Morning Session, September 10th.

After various announcements were made, President O'Malley, as Chairman of the Committee to further the amalgamation of the Pacific Fisheries with the American Fisheries Society, presented the following report:

Two years ago I was appointed chairman of a committee to look into the amalgamation of the Pacific Coast Fisheries Society with the American Fisheries Society. Last year the Pacific Coast Fisheries Society voted to amalgamate with this Society and we proceeded to take it under advisement and work it out, but when we got into the proposition, we found that the By-laws of the American Fisheries Society had defeated our cause, since they stated that we must have 100 members signed from the societies desiring to amalgamate. The Pacific Coast organization, I believe, had between seventy and seventy-five members at that time; therefore we can not go any further until action is taken by this society.

Secretary Titcomb presented the following, relative to the amalgamation of another society with this organization:

A few months ago, as representative of the Conservation Commission of this State, I attended a meeting of the National Association of Fish Commissioners. That was originally the Association of Shell Fish Commissioners, if I remember correctly. The members are more interested in shell fish than anything else. We therefore have this National Association of Fish Commissioners, the International Association of Fish and Game Commissioners and the American Fisheries Society, to a large extent working along the same lines—especially the National Association of Fish Commissioners, so far as the fisheries are concerned—and at that time the question was brought up of amalgamating that association with this one. It is quite a burden on some people to attend and on some states to send representatives to meetings of all these organizations at different seasons of the year, and it is a matter of criticism sometimes, when expenses are incurred by state officials for going out to so many of these meetings. I understand that there is here present a committee from the National Association of Fish Commissioners ready to talk over this question of amalgamating with the American Fisheries Society, and for that reason I move that the President be empowered to appoint a committee to confer with this committee of the National Association, with a view to amalgamation, and that he himself be included on the committee as an ex-officio member.

The motion was put and carried, and President O'Malley appointed Messrs. Geo. H. Graham, G. C. Leach and Raymond C. Osburn as members of the Committee.

The reading and discussion of papers was then resumed:

The Elimination of Stream Pollution in New York State.

BY DR. HENRY B. WARD,
University of Illinois.

This has already been published, together with the discussion which followed, in the TRANSACTIONS for December, 1918, pp. 3 to 25.

REPORTS OF THE TREASURER.

Annual Report.

To the American Fisheries Society:

I hereby submit my annual report as Treasurer, from the annual meeting in August, 1917, to August 21, 1918:

RECEIPTS.

Balance in the treasury		$ 664.24
Interest on deposits		7.39
Life membership		25.00
Annual dues:		
For year 1912	$ 2.00	
For year 1913	4.00	
For year 1914	8.00	
For year 1915	26.00	
For year 1916	68.00	
For year 1917	276.00	
For year 1918	60.00	
For year 1919	6.00	
		450.00
		$1,146.63

DISBURSEMENTS.

Per Cash Book:

Exchange for August	$ .10
Rexford Holmes (Reporting, on account) S. V. 1	25.00
L. B. Rimbach, express 39c; clerical services as Treasurer pro tem Oct., 1916, to Aug., 1917	100.39
Carlos Avery, postage to August, 1917	23.16
Leader Printing Co., letterheads	8.25
Emerson & Co., rubber stamps	3.15
Postage	9.56
Clark & Fritts, June Transactions, etc	195.15
Deposit life membership fee in Permanent Fund	25.00
Postage	1.00
Clark & Fritts, Sept. Transactions	98.11
John W. Titcomb, postage	15.00
Joseph C. Pedlow, multigraphing	4.75
L. B. Rimbach, postage and telegram	.94
J. B. Lyon Co., letterheads and envelopes	9.90
Rexford L. Holmes, reporting 47th Annual Meeting, Aug. 29–31, 1917	125.67
M. Riddell, multigraphing	2.70

L. B. Rimbach, postage	11.00	
The J. C. Hall Co., receipt blanks	4.58	
John W. Titcomb, postage and express	16.64	
J. C. Pedloe, Jr., multigraphing	5.00	
Industrial Trust Co., advertising lost passbook	2.70	
J. B. Lyon Co., letterheads, etc	28.25	
Sphar & Glenn, December '17, and May '18 Trans	182.04	
Joseph C. Pedloe, multigraphing	4.00	
L. B. Rimbach, clerical services Aug., 1917, to Aug., 1918	100.00	
Gloucester National Bank, to cover check of Mr. Rew, deposited to account of American Fisheries Society, but proved uncollectible	2.00	
		1,004.04
Balance per Cash Book		$142.59

ARTHUR L. MILLETT,
Treasurer.

Gloucester, Mass., Aug. 21, 1918.

Mr. Millett explained that the above report does not include $125.00 paid out to cover bills for 1917.

PERMANENT FUND.

Concerning the Permanent Fund of the American Fisheries Society I have to report that this fund is on deposit with the Industrial Trust Co., Westerly Branch, Westerly, R. I., and the pass-book shows a balance of $2,995.96.

ARTHUR L. MILLETT, *Treasurer.*

Gloucester, Mass., Aug. 21, 1918.

The Auditing Committee, Mr. John R. Woods, Chairman, having already examined the accounts and pronounced them to be correct, the Report of the Treasurer was accepted.

The Treasurer, Mr. Millett, was compelled to leave at this time and Mr. Geo. H. Graham was appointed to serve in his stead during the remainder of the meeting.

The session was then adjourned.

Tuesday Afternoon Session, September 10th.

The discussion of Dr. Henry B. Ward's paper was continued for some time and the question was raised as to the best way to reach the people with information in regard to the pollution problem.

Mr. Geo. H. Graham moved that Dr. Ward be asked to prepare his paper immediately and that a copy be sent to each of the fish and game commissioners, and that they in turn give it publicity in the newspapers of the various states. The motion was carried.

Mr. G. A. Smith, of Oklahoma was called upon to read his paper entitled:

Stream Pollution.

This paper with the discussion that followed will appear in a later number of the TRANSACTIONS.

COMMITTEE ON RESOLUTIONS.*

The Committee on Resolutions, through its Secretary, Mr. John P. Woods, presented the following resolutions for the consideration of the Society:

I. WHEREAS, there are upon the roster of this Society the names of certian enemy aliens; and

WHEREAS, it is distinctly repugnant to the loyal spirit of this Society thus to harbor such undesirables and to be thus burdened thereby; therefore

Be it Resolved, that each and every such enemy alien be hereby expelled instantly from membership in this Society; and

Be it further Resolved, that any member who may have been or may hereafter be convicted of disloyalty to the United States be automatically expelled; and

Be it further Resolved, that the Executive Committee, with the Secretary, be invested with the authority to make all such eliminations, the Committee duly to second each disbarment, and to report back to the Society its findings and actions.

It was moved and seconded that this resolution be adopted, whereupon it was unanimously carried.

II. WHEREAS, the supply of red meats for the customary food purposes, but more especially and decidedly for the successful conduct of the war, to supply our army and our allies satisfactorily, is one of the prime objects to be now attained; and

WHEREAS, the suitability of fish as a human food presents itself impressively now, not merely as an acceptable substitute for meat, but as a beneficial food alternative, it being noted for its great bulk, its moderation in cost, and its otherwise general adaptability for food consumption; therefore,

Be it Resolved, that this, the American Fisheries Society, respectfully and faithfully dedicates its first and full aid, not only to the maintenance, but to the increase, of the supply of fish, promising further to employ its

*See also pp. 91 and 111.

skill and entire ingenuity to the end of attempting to overcome any of the perplexities of the present or the future, which there is any possibility to anticipate or formally respond to; and

Be it further Resolved, that a copy of this resolution be promptly forwarded to the Honorable Secretary of War and the United States Food Administration.

This resolution was also approved unanimously.

III. WHEREAS, there comes regularly to the serious attention of the American Fisheries Society the need of abatement of certain pollution of certain streams and certain tidal waters, which pollution in many cases is the result of oversight occasioned by the quick and abnormal growth of essential industry, and which in many cases also can be easily remedied without in any way impairing the usefulness of such industries; and,

WHEREAS, the aforesaid pollution is at present destroying great volumes of human food, with the imminent prospect of irreparable future damage;

Be it therefore Resolved, that the proper authority of the Federal Government be requested to call and to meet a conference committee from this Society purposely to consider certain measures to be proposed for control and abatement; and,

Be it further Resolved, that a copy of this resolution be forwarded to the Honorable Secretary of War, the United States Food Administrator, and the War Industries Board.

The reading of this resolution precipitated a somewhat lengthy discussion as to the advisability of asking government co-operation in such matters. Some of the members seemed to feel that the rights of the various states to full control of their fisheries and unnavigable waters might be involved.

The question was finally put to vote and the resolution carried with two dissenting votes.

Later action by the Society provided a committee which has been appointed by President Alexander.

COMMITTEE ON POLLUTION OF STREAMS.

Prof. Henry B. Ward, Chairman, University of Illinois; Mr. John N. Cobb, Director, School of Fisheries, Seattle, Washington; President E. A. Birge, Wisconsin University; Mr. Wm. C. Adams, Fish and Game Commission of Massachusetts; Mr. J. A. Williams, Shell Fish Commissioner of Florida; Mr. E. A. Tulian, Conservation Commission of Louisiana, and Mr. Seymour Bower, U. S. Bureau of Fisheries, Comstock Park, Michigan.

The following resolutions were acted upon at a later session, but for convenience in reference are inserted here.

IV. WHEREAS, federal provision for the erection of federal hatcheries has been made, and whereas the need therefor in the near future is imperative,

Be it therefore Resolved, that the American Fisheries Society respectfully urge the Bureau of Fisheries to use all possible speed in making operative the proposed hatcheries in so far as is compatible with interests not interfering in any way with the conduct of the war, and that a copy of this resolution be duly presented to the Bureau of Fisheries.

Carried unanimously.

V. WHEREAS, the conditions of the present have shown the need of developing the food resources of the country to meet the demands not only at the present moment, but also in the future, and

WHEREAS, the opportunities for securing specific training in the principles of fish culture are extremely limited if not entirely lacking in the educational institutions of the country, and

WHEREAS, such training is important not only in the service of the state and nation, but also to the individual land owner who can advantageously engage in fish production on a small scale in connection with his agricultural activities; therefore

Be it Resolved, that the American Fisheries Society recommend the establishment of courses in fish culture which will open a new field of activities for many who find themselves adapted to such work and at the same time furnish a force of trained workers to meet the demands of state and nation.

That this end may be achieved in the most effective fashion, the President of the Society is hereby directed to appoint a committee to consider plans of procedure.

The resolution was carried unanimously. President Alexander has since appointed the following:

COMMITTEE ON UNIVERSITY COURSES IN FISH CULTURAL WORK.

Prof. G. C. Embody, Chairman, Cornell University; Dr. R. E. Coker, U. S. Bureau of Fisheries; Mr. John W. Titcomb, State Fish Culturist of New York; Prof. Jacob Reighard, University of Michigan; Prof. Raymond C. Osburn, Ohio State University.

VI. *Be it Resolved,* that the American Fisheries Society in convention assembled, requests that the United States Bureau of Fisheries prepare a comprehensive plan for the protection and improvement of the Shad Fishery industry, including suggestions for necessary state legislation; and that when such plan has been prepared, it be forthwith submitted to the proper

authorities in each state interested in Shad Fisheries, with the urgent request for immediate co-operation, to the end that this great industry may be preserved.

Carried, with no opposing votes.

A committee provided for later has been appointed by President Alexander, as follows:

COMMITTEE ON THE REHABILITATION OF THE SHAD INDUSTRY.

W. H. Killian, Chairman, Baltimore, Md.; G. C. Leach, U. S. Bureau of Fisheries; Adrian Thomas, Richmond, Va.; F. Nash Bilisoly, Norfolk, Va.; Wm. C. Adams, Boston, Mass.

VII. WHEREAS, the Almighty has taken from our midst the following members, namely, Daniel B. Fearing, of Rhode Island; R. M. Hurley, of Pennsylvania; John S. Parsons, of Virginia; John R. Rew, of Virginia; A. R. Stark, of Pennsylvania; A. R. Whittaker, of Wisconsin; M. F. Stapleton, of Wisconsin; Frank E. Hitchings, of Massachusetts; and Dr. Richard Rathbun, of the U. S. National Museum; thus necessitating again the sorrowful record of deaths within the portals of this Society;

Therefore, be it Resolved, that this Society, realizing the extent of the loss, and moved by its feelings of deepest emotions and sympathy, does hereby indicate its full sorrow in its expression of bereavement over the newly made graves.

The resolution was unanimously passed by a rising vote in honor of the memory of the deceased members.

The reading of papers was resumed and Dr. Prince was called upon.

A New Form of Fish-way, with Models and Demonstration.

BY DR. E. E. PRINCE,
Dominion Commissioner of Fisheries, Ottawa, Canada.

This paper will appear, with discussion, in a later number of the TRANSACTIONS.

Minnesota's Experiment in State Fishing.

BY MR. CARLOS AVERY.
St. Paul, Minn.

This paper has already been published in the TRANSACTIONS for December, 1918, pp. 57 to 64.

Discussion.

MR. GEO. D. PRATT, of New York: Will Mr. Avery state how the cost was computed, who were employed to do the fishing and on what basis they were paid?

MR. AVERY: We made no computation to start with, except in a very general way. Our experience has shown that we can sell these fish at prices of one-half to two-thirds of the ordinary selling prices for the same varieties and pay operating expenses and provide equipment in some cases. We employ men experienced in fishing—fishermen, settlers and Indians living near the lakes. They furnish their own equipment and we pay them by the pound.

SECRETARY TITCOMB: Did the sportsmen raise any objections? We have found it difficult to convince them that nets will not drain the lake of fish.

MR. AVERY: There was none when they understood what we were doing. We have not fished where there are any bass, and the only protected fish in the waters concerned were the white perch or wall-eyed pike, but they are of inferior quality and no one cares to fish for them. The only protests came from the wholesale fish dealers, but they have finally subsided and these men are now handling our fish.

MR. W. E. BARBER, of Wisconsin: The State of Wisconsin took up the matter of distributing rough fish generally throughout the state a year ago last May. The commercial fishermen operating in inland waters work under a state contract and they received for these rough fish four and a half cents a pound. The State Food Administration sent out circulars notifying the cities that the fish could only be secured by order from the State Conservation Commission. The various cities established markets and were allowed to charge five cents per pound. No butcher shop or other institution than the city was permitted to handle the fish and it worked out very successfully. Thirty or forty towns and cities took advantage of the opportunity and the people were very eager to buy fish. In no instance did it take over a couple of hours to dispose of the stock and some cities ordered as high as ten thousand pounds at a time.

MR. JOHN P. WOODS, of Missouri: May I express my appreciation of the efforts that have been made towards starting a modern "eat fish" campaign. In my state we have no such opportunities. One feature appeals to me and that is the prospect of dissipating the idea that fish should not be available except on Friday. I had the honor of presenting a paper at the New Orleans meeting opposing the prevailing custom of eating fish only on Fridays and I am glad to welcome this innovation.

Territorial Waters and a Suggested Extension of the Three-Mile Limit.

BY DR. E. E. PRINCE,
Dominion Commissioner of Fisheries, Ottawa, Canada.

This paper, together with the discussion, will appear in a later number of the TRANSACTIONS.

The session adjourned.

Tuesday Evening, September 10th.

At the invitation of Dr. Chas. H. Townsend, Director of the New York Aquarium, the members of the Society spent the evening at the Aquarium as guests of the New York Zoological Society. As the reception took the form of a "smoker," ample opportunity was afforded for the guests to inspect the numerous interesting exhibits of fishes and other aquatic animals at their leisure. Later in the evening a series of lantern slides and motion pictures of fishes and various fisheries operations was thrown upon a screen and refreshments were provided.

Wednesday Morning Session, September 11th.

Reading of papers and discussion.

A Tray for Sorting Fish.

BY WM. H. ROWE,
West Buxton, Me.

The importance of sorting fish is known to every fish culturist. From the time they begin to feed—and some grow faster than others—there is danger of the larger eating the smaller. As they grow it is an advantage to put the larger ones by themselves, and the smaller ones that are left have a much better chance.

Necessity may have led many a fish culturist to construct some such a device as I have made, but I have never seen one in any hatchery I have visited. The first year of my hatchery experience I sorted fish by picking them out of a tub of water one at a time and putting them into other tubs or pools, according to size. This method is very slow. I have tried a long box fitted with racks with wire or slats to hold the larger trout and let the smaller through, but this method was never satisfactory, as many of the fish that could go through would not do so.

A few years ago, having many fish on hand that needed sorting, (with little time to do it in and cold weather), I wondered if I could not use a tray such as is used for sorting apples or potatoes. I made such a tray about 3 feet long by 15 inches wide, with low sides about 2 inches high and having bagging tacked on the

bottom with strips of wood 1 inch by ½ inch. I also made a frame that would just fit on over the 2-inch sides and that could be easily removed. This frame, made of strips 5 inches by ½ inch, is to be used for larger fish when there is danger of their going over the low sides of the tray, but in most cases it is not necessary to use this.

I have found this tray one of the most convenient articles I have about the hatchery and it comes into almost daily use. For sorting fingerlings and yearlings, I place it on a box, open side up, about the size of the tray, that will bring the tray a foot or more from the ground and placed directly back of the pool into which the larger portion of the sorted fish are to be put. The fish are seined up and placed in a tub of water near the tray. One man, with a dip net, will take from the tub and put into the tray as many at a time as can be handled conveniently. A man or two by the tray can pick out the largest of the lot (and the smallest also if three sortings are to be made), and these are put into tubs and later into pools. Those remaining in the tray are tipped into the pool in front of the tray.

In most cases this saves taking in the hands a large proportion of the fish. A tub of yearlings, holding a thousand to fifteen hundred fish, can be sorted in fifteen minutes. In sorting for the market, those large enough to ship can be picked out by hand and the balance tipped back into the pool.

I make use of this same tray in spawning time, placing several trout at a time in it and taking the fish to be stripped from the tray. In this way they get rid of the water that would run into the spawning pan if the fish were taken in the hands from water, thus increasing the chances of good fertilization.

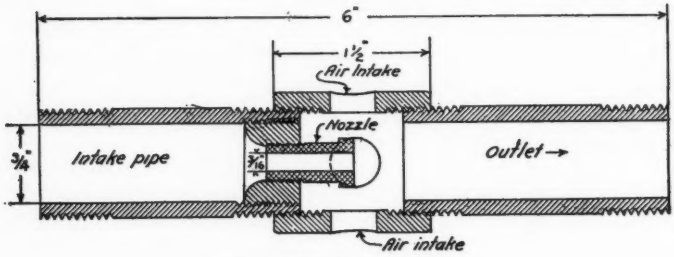
I have had several fish culturists from United States, state and commercial hatcheries working with me, but none of them had ever seen the tray used for sorting fish until they saw the one at my place. Although it is not in general use, I think, from its simplicity, someone must have made a device much like the one I have. It certainly is a great labor saver.

In the discussion which followed, Mr. J. P. Snyder, of Cape Vincent, N. Y., described a sorting tray which he had made, using galvanized wire screen on the sides of the tray. With the use of screen of various sizes any desired assortment could be made in a short time.

An Aerating Device.

BY JOHN W. TITCOMB,
State Fish Culturist of New York.

The New York State Conservation Commission recently had a live fish exhibit at the Rochester Exposition. The water supply was from a large lake inhabited by lake trout, white fish and several other species, but as supplied to the aquaria through the city water mains it evidently was lacking in air or something of that sort. We had no difficulty in keeping most of the fish in good condition, but we lost small-mouth bass continuously for the first two days of the exhibit, or until the city plumber who had installed the piping came around with this aerating device. It is patterned after the Bunsen gas burner. The water supplied to the aquarium, passing through this aerator, sucks the air through the holes in the union and carries it down into the aquarium, say fifteen or eighteen inches. When the pipe connected with this aerator was extended to the bottom of the aquarium, a depth of from 2½ to 3



LONGITUDINAL SECTION

ELEVATION

Plan of aerating device, as devised and constructed by Mr. Norman Price, Rochester, N. Y., reduced one-third.

feet, there was not sufficient force in the discharge of water to carry the air to the bottom, but some of the water would discharge through the air holes in the union. Any difficulty of this sort can be adjusted so as to use the minimum amount of water and, at the same time, force into the aquarium a considerable amount of air. The aerator is attached to the regular supply pipe leading to the aquarium and setting vertically a few inches above the water level. The nozzle shown in the drawing is not absolutely necessary, the water discharging directly from the plug in the intake pipe having sufficient force to suck the air through the holes in the union and driving it into the aquarium.

This simple device was suggested by Mr. Norman Price, a plumber who had never had anything to do with fish except to catch them. After it was applied to the aquarium containing the small-mouth bass we did not lose a fish. It is proposed to install the device in every one of the aquaria, not only to improve the condition of the water for all the fishes, but because it permits the use of less water. The size of the pipe and the size of the holes both in the union and in the nozzle or plug may be varied to suit conditions.

Discussion.

DR. R. C. OSBURN: I wish to ask Mr. Titcomb if the air is well distributed in small bubbles. With compressed air driven through wooden plugs there is a very fine distribution of the air, but if this apparatus is effective in that respect it does away with all secondary means of aeration and should be especially useful for temporary aquaria.

MR. TITCOMB: The air is broken up into a cloud of white. The amount and the size of the bubbles can be regulated very largely by the pressure under the control of the supply valve.

MR. CHAS. O. HAYFORD, Hackettstown, N. J. This device should be very useful to hatcheries. In those that use spring water, there is often a great lack of oxygen. Another thing that troubles us is the jumping at the intake of our ponds and this device should tend to eliminate some of that. It is so inexpensive that it is worthy of a trial by all of us.

MR. G. C. LEACH, U. S. Bureau of Fisheries: How far above the water is the apparatus placed, and have you ever experimented with low pressure, such as is usually in use around hatcheries?

MR. TITCOMB: It makes no difference where you place it, the air is carried successfully. We have not experimented with low pressure. I think there is a chance for experiment by varying the size of the holes according to the amount of water you have.

MR. LEACH: It will be an interesting experiment to try this with a three-inch pipe. If it works well with pipe from two to three inches, we could use a very low head of water at the intake, with a larger opening, and it might prevent the fish from jumping and also aerate the water.

Model of a Riffle Pond, for Rearing Small Fingerling Trout.

DESIGNED BY MR. GEO. A. SEAGLE,
Wytheville, Va.

PRESENTED BY MR. G. C. LEACH,
U. S. Bureau of Fisheries.

The ponds are constructed entirely of concrete, except outlet pipe and guard-screens, and are from 4½ to 9½ feet wide and 50 feet long; with water 6 to 10 inches deep at upper end, and 20 to 30 inches deep at lower end when pond is filled. These ponds were first built without riffles, but were unsatisfactory, as the fish would crowd around the foot screens and in the corners of the pond. At that time only about 5,000 No. 1 fingerling fish could be kept in one of the small ponds, and it was necessary to take them up for treatment for a slimy affection every ten days or two weeks, which was always attended by some loss of fish. The riffle ponds have been in use two seasons, and have given excellent service; from 30,000 to 35,000 are carried successfully where only 5,000 were carried before the ponds were changed. In several instances the fish were placed in the riffle ponds before they had been fed, and they were reared to No. 2 fingerlings with only one change, and that was for the purpose of assorting the fish as to size.

The riffles were designed to furnish a means to exercise the fish, which is very essential to keep the young fish in a thrifty condition. To exercise the fish it is only necessary to draw out the first paddle, which will reduce the water to the desired depth, and the fish will scatter out to all the compartments. When they are properly constructed, and are working well, the water should be about 1¼ inches deep above the riffle, and ¼ to ⅜ in. deep at the foot of the riffle above. This is easily governed by placing the riffles at the proper distance apart, according to the drop in the bottom of the pond, which should not be very great, say about one inch in four feet. From 25 to 40 gallons of water per minute

is about the average supply, but that can be determined by local conditions. The working of the riffles will suggest the proper amount of water to be used for good results.

Discussion.

In answer to questions, Mr. Leach explained that the fish were sometimes placed in the pond before they are large enough to require feeding and that 35,000 to 40,000 fingerlings, up to four and a half inches long, can be carried successfully where before not more than 5,000 could be handled. At night the pond is allowed to fill and in the morning is drawn down so that the fish distribute themselves over the various riffles.

SECRETARY TITCOMB: The fish culturists here know well enough that a fifty foot pond five feet wide should be able to carry more than 5,000 fry to start with. Mr. Seagle, who is one of our most ingenious fish culturists, has overcome a condition of the water in which he was able to carry only 5,000. I think the very idea he has used is something we should experiment with in all our ponds. Perhaps the ponds in which we now carry 35,000 may be made to carry 100,000 or more. While he has overcome a local condition, the suggestion may be just as valuable for all of us to consider.

MR. LEACH: That is the idea. It would seem that many stations could increase their carrying capacity or conserve their water supply.

MR. DEROCHER: The device is a very good one, but I would suggest a change in the outlet of the pond. The drain should be arranged to come down flush with the end of the pond, thus avoiding dead water pockets which give a chance for sediment and waste to collect.

MR. LEACH: The criticism is a good one. I would prefer the outlet so placed.

The Shad Outlook.

BY MR. J. P. SNYDER,
Cape Vincent, N. Y.

The paper read by Mr. Snyder, with a digest of the discussion which followed, appears in this number of the TRANSACTIONS at p. 113.

The Development of Fresh Water Mussels and Their Culture.

BY DR. ARTHUR DAY HOWARD,
U. S. Bureau of Fisheries Biological Station, Fairport, Iowa.
(Read by Dr. Raymond C. Osburn.)

This valuable paper has not yet been published.

The session adjourned.

Wednesday Afternoon Session, September 11th.

Secretary Titcomb called the attention of the members present to the necessity of meeting their annual dues in order to keep up the publications of the Society. He also urged them to use their influence in securing a larger membership for the Society, pointing out the fact that the publications of the Society afford the only means for commissioners and fish culturists to keep abreast of the times in this particular subject.

REPORT OF COMMITTEE ON TIME AND PLACE OF MEETING.

Mr. John P. Woods, Chairman, reported that the committee had met in joint session with a similar committee from the International Association of Fish and Game Commissioners. Invitations were considered from Jacksonville, Chicago, Philadelphia, Buffalo, St. Louis, Louisville and Albuquerque.

The Committee recommended that the invitation presented by Mr. Theo. Roualt, Jr., State Game Warden of New Mexico, to hold the 1919 meeting in Albuquerque, New Mexico, be accepted, and that the time be set for the week beginning Monday, Sept. 15.

The report of the Committee was not acted on at once, but later in the meeting Mr. Wm. C. Adams, of Massachusetts, presented a motion to the effect that the Society designate Albuquerque, New Mexico, as the next place of meeting, provided that in the opinion of the Executive Committee at or near the usual time for issuing the annual announcement, war conditions warrant meeting at that place, and provided further that other conditions, in the opinion of the Executive Committee warrant the calling of the meeting at Albuquerque.

This motion was unanimously carried.

REPORT OF COMMITTEE ON NOMINATIONS.

Dr. Henry R. Ward, Chairman of the Committee presented the following names of members as the unanimous selection of the Committee for the officers of the Society for the year 1918–19:

President.....M. L. ALEXANDER, New Orleans, La.
Vice-President.....CARLOS AVERY, St. Paul, Minn.
Recording Secretary.....JOHN P. WOODS, St. Louis, Mo.
Corresponding Secretary.....CHAS. H. TOWNSEND, New York City
Treasurer.....ARTHUR L. MILLETT, Gloucester, Mass.
Editor.....RAYMOND C. OSBURN, Columbus, Ohio

Executive Committee.

N. P. BULLER, *Chairman*.....Harrisburg, Pa.
GEORGE D. PRATT.....Albany, N. Y.
W. A. FOUND.....Ottawa, Canada
WM. H. ROWE.....West Buxton, Me.
W. E. BARBER.....Lacrosse, Wis.
W. H. KILLIAN.....Baltimore, Md.
CARL WESTERFELD.....San Francisco, Cal.

Committee on Foreign Relations.

GEO. SHIRAS, 3D, *Chairman*.....Washington, D. C.
HUGH M. SMITH.....Washington, D. C.
WM. G. ADAMS.....Boston, Mass.
JAMES WHITE.....Ottawa, Canada
C. H. WILSON.....Glens Falls, N. Y.

Committee on Relations with National and State Governments.

GEO. H. GRAHAM, *Chairman*.....Springfield, Mass.
W. L. FINLEY.....Portland, Ore.
JACOB E. REIGHARD.....Ann Arbor, Mich.
E. T. D. CHAMBERS.....Quebec, Canada
HENRY O'MALLEY.....Seattle, Wash.

It was moved and seconded that the Secretary be instructed to cast a unanimous ballot for the Society. The motion was carried and the President declared the officers elected for 1918–19.

The Committee begged for more time in which to present the names of Vice-Presidents of Divisions and later, at the evening session, the following were elected:

Vice-Presidents of Divisions

Fish Culture.....DWIGHT LYDELL, Comstock Park, Mich.
Aquatic Biology and Physics.....HENRY B. WARD, Urbana, Ill.
Commercial Fishing.....CHARLES LAY, Sandusky, Ohio
Angling.....J. M. McDOUGAL, Gunnison, Colo.
Protection and Legislation..GEO. A. LAWYER, Washington, D. C.

A resolution in regard to the protection and improvement of the Shad fisheries, drawn up by Mr. Wm. C. Adams, of Boston, Mass., was presented at this time by the Resolutions Committee and acted upon. See Resolution VI under the heading "Report of the Committee on Resolutions."

Food Studies in Relation to Pond Fish Culture.

BY AUSTIN F. SHIRA,
Director, U. S. Biological Station, Fairport, Iowa.
(Read by Dr. Raymond C. Osburn.)

This paper will be published later. It was briefly discussed by Messrs. Titcomb, Osburn and Woods.

President O'Malley introduced the President-elect, Mr. M. L. Alexander, who made a brief address:

"*Mr. President and Gentlemen of the Society:* First I wish to congratulate you upon the success of this splendid meeting and upon the successful administration of the past year under the direction of our President, Mr. O'Malley. I wish, also to express to you my deep appreciation of the great compliment you have paid me, personally, in electing me to the presidency of this, the first society of its kind in the United States and possibly in the world, and to assure you that I feel the honor deeply. This honor will be appreciated not only by the people of my state but also of that entire section of the country. I am neither a scientific nor a technical man, but in the administration of the office of president and of the affairs of this Society I hope to be able to put into that work the best that's in me, and through the co-operation of the scientists and technical experts in our organ-

ization we will carry this Society to a higher degree, if possible, throughout the administration of the next year.

"At no time in the history of the Society has there been more important work for us to perform. The needs of the government at this time are great indeed, and it is our duty and our obligation to offer to our government at this time our heartiest co-operation and support in carrying out any measures suggested for the production of more sea-foods and fish-foods, so that the government will have the greatest utilization possible of the meats which are so necessary for our armies and those of our allies. Therefore, I call upon every member of this Society and every state commissioner belonging to it, to give to the government his best support in the production of more fish for food and in the education of the people in the eating of fish. Further than that, I believe it is our duty to see that fish food is supplied to the people of the United States at a price at which they can afford to purchase it and not be forced to eat meat.

"We should take up with great vigor this question of the pollution of streams which has been considered with such seriousness at this meeting and do everything possible to back up any movement to eradicate this great evil that exists throughout the whole land, so that our streams will supply the requisite amount of fish food.

"We should take up our work along constructive lines, so that this Society will stand for something that makes for the real good and the larger development of the great resources of this nation."

A motion was passed instructing the Secretary of the Society to extend the thanks of the Society to the New York Zoological Society for the previous evening's entertainment at the New York Aquarium.

REPORT OF THE COMMITTEE ON AMALGAMATION OF THE NATIONAL ASSOCIATION OF FISH COMMISSIONERS WITH THE AMERICAN FISHERIES SOCIETY.

The chairman, Mr. Geo. H. Graham, stated that the Committee had met, and, after much discussion of the matter, decided to request that the matter be laid over until the next annual meeting. The reasons for this delay are, that the By-laws of the American Fisheries Society do not at present permit of the amal-

gamation with other organizations having less than one hundred members, which would exclude the society in question; and, second, it was thought best to inform all of the members of the National Association of Fish Commissioners (formerly the Shell-Fish Commissioners Association) by letter, of the proposed amalgamation and state the idea to them explicitly. In the meantime the American Fisheries Society may well modify its By-laws in such a manner as to permit the amalgamation.

The session adjourned.

Wednesday Evening Session, September 11th.

The members of the Society were entertained at a clam bake as the guests of the New York Commissioner of Conservation, Mr. Geo. D. Pratt, at his Long Island home, an occasion long to be remembered by those present. At the close of the feast the Society was formally convened for the transaction of remaining business.

COMMITTEE ON NOMINATIONS.

Dr. Henry B. Ward, the chairman, submitted the list of names for Vice-Presidents of Sections and the Society unanimously voted for their acceptance as officers. The list oppears on page 108, along with those of other officers of the Society.

COMMITTEE ON BY-LAWS.

The Committee, through its chairman, Dr. Ward, recommended the following changes:

I. Amending Article III, first paragraph, to read as follows: "On presentation of a formal written petition signed by one hundred or more members, or by vote of the Society together with the written request of the officers thereof, the Executive Committee of the American Fisheries Society may approve the formation in any region of a section of the American Fisheries Society to be known as the ——— Section."

II. Amending Article IV, last paragraph, to read: "Vice Presidents of sections may be called upon by the President to present reports of the work of their sections, or they may voluntarily present such reports when material of particular value can be offered by a given division."

These changes were unanimously approved by vote of the Society.

COMMITTEE ON RESOLUTIONS.

The secretary of the Committee, Mr. John P. Woods, presented Resolution No. VI (see page 97), which was approved.

Mr. M. L. Alexander, as chairman of the Resolutions Committee, claimed the privilege of presenting the following resolution in person:

Resolved, that the American Fisheries Society and the International Association of Fish and Game Commissioners hereby express their very great appreciation of the delightful and open-handed hospitality which has been extended to us on this visit to New York, and especially for the great treat afforded us last evening by Dr. Townsend and the New York Zoological Society, and for the gracious hospitality extended to us this evening by Mr. Pratt, Conservation Commissioner of the State of New York; and also that we extend our thanks to the members of the Local Committee for their work in connection with this very successful meeting.

It is gratifying to know that we have met here as representatives of all parts of this great country, that any sectional lines which may have existed in the past have been obliterated, and that we stand shoulder to shoulder, working for one common cause, desiring to do everything possible to aid our government in its endeavors to carry on this great war to a successful issue.

The resolution was unaimously approved by a rising vote.

Commissioner Pratt, the host of the evening, was called upon and responded with a brief address.

COMMITTEE ON AWARDS.

The secretary of the Committee, Dr. Henry B. Ward, presented the following report:

The Committee feels that the society is to be congratulated on the response that has been made to the plan proposed by President O'Malley, under which prizes have been offered for new contributions in this field of activity. Sixteen papers have been offered in competition for these prizes and among them are so many of originality and value that the adjudication of the prizes has involved both intensive and time-consuming study by the Committee.

One of the papers, entitled "Working Plans for Increasing Fish Production in the Streams of Oneida County," has been submitted for consideration by the New York State Conservation Commission. The Committee is of the opinion that this does not fall within the terms of the competition because (1) it has not been submitted by an individual member, and (2) it has already been published. However, it represents so new and important

a line of investigation that the Committee wishes to recommend a vote of Honorable Mention to the New York State Conservation Commission for the scientific work organized and conducted under its auspices, as especially represented by the survey of Oneida County submitted to the Committee. Only one paper on the problems of the commercial fisheries has been submitted for consideration, viz.: on "The Development of Markets for Neglected Fishes," by Lewis Radcliffe, U. S. Bureau of Fisheries.

This appears to the committee to constitute a most valuable summary of the important work done in introducing new fishes and extending the knowledge of foods and increasing public demand for them. It seems in consequence to be historical and not exactly within the scope of the competition. Therefore the Committee recommends that no prize be awarded under this heading.

For the best contribution on biological subjects a prize of $100.00 was awarded to Dr. Morgulis for his paper on "Studies on the Nutrition of Fish: Experiments on Brook Trout."

For the best contribution on fish culture a prize of $100.00 was awarded to Dr. Embody for his paper on "Results of Some Trout Feeding Experiments Carried on in the Experimental Hatching Station of Cornell University."

President O'Malley called upon Mr. E. T. D. Chambers, Deputy Commissioner of Colonization, Mines and Fisheries for Quebec, Canada. Mr. Chambers responded with a brief address in which he expressed his pleasure that our "marching together in a common cause has largely done away with those old divisional lines which formerly separated our beloved countries." He presented an invitaiton from the Commission of Colonization, Mines and Fisheries of Quebec to hold an annual meeting of the American Fisheries Society in Quebec in 1920.

President-elect Alexander accepted the chair for the remainder of the session at the invitation of President O'Malley, and called upon Dr. F. T. Sun, President of the School of Fisheries of Tientsin, China. Dr. Sun replied briefly, expressing the pleasure he had experienced in attending the meeting and invited the members to visit him in China. He explained his inability to continue at length as due to the elaborate banquet and also to the fact that the other members had the advantage of him by thirty years or so in the use of the English language.

President-elect Alexander brought the meeting to a close with a few remarks and the Forty-eighth Annual Meeting of the American Fisheries Society was formally adjourned.

THE SHAD OUTLOOK (Alosa sapidissima).

BY J. P. SNYDER,
Cape Vincent, N. Y.

During the spring of 1917, while assisting the Maryland Conservation Commission, the writer spent several weeks among the fishermen along the following rivers: Pocomoke, Wicomico, Nanticoke, Choptank, Tuckaho, and Chester. Particular attention was paid to those parts of these rivers that are the natural spawning beds of shad. This was done with a view to getting some definite idea as to the number of shad that spawned on these beds as compared with fifteen or twenty years ago. In this report no reference is made to men who were not actual fishermen for shad, either with pound nets or with gill nets, and who had not fished successively for fifteen or more years, and every effort was made to impress upon them the necessity of being honest and conservative in their answers. The men individually were asked to give, as near as they could recall—and quite a few had records to which to refer—the smallest, the largest and the average catch made per day's fishing during the springs of 1916 and 1917. Then they were asked to go back in retrospect and give as near as they could recall their smallest, largest and average catches per day's fishing in 1902 and 1903. All this information was taken down and tabulated and from these tabulations averages were worked out.

On the Pocomoke River, from Pocomoke City to Snowhill, seventeen fishermen were interviewed. It was shown from the testimony of these men that only one-tenth as many shad reached their natural spawning beds on that river in 1916 and 1917, as compared with 1902 and 1903.

On the Wicomico River from Salisbury to eight miles below that city, according to the testimony of nineteen fishermen, but one-twelfth as many shad returned in 1917 as did fifteen years before that date.

Twenty fishermen were interviewed along that part of the Nanticoke River from Woodland, Del., to Sharptown, Md. According to the information given but one shad was taken per net in 1916 and 1917 as compared with fifteen during the springs of 1902 and 1903.

Along the Choptank River from Hillsboro to Williston twelve shad were taken per net in 1903 as compared with one in 1917. The same ratio held good on the Tuckaho in the vicinity of Ridgley.

This same ratio also held on the Chester River from Chestertown to Millington, according to the testimony of twelve fishermen of record.

Along all these rivers the testimony of the men of record was strengthened by the testimony of many men who fished years ago, but not in recent years, and by other men who fished only during recent years.

During the spring of 1918 the writer spent a couple months on the headwaters of Chesapeake Bay; on that part of the bay that was long noted for the vast number of shad that collected there each year to spawn; where the Bureau of Fisheries, years ago, made such great records in the propagation of these fish. On these beds years ago Callighan and Hogan, and over near Charlestown, Barnes, operating large seines, frequently captured from 500 to 2,000 shad at a haul. Last spring parties operating a seine more than a mile long on these same beds rarely took more than two or three shad at a haul, while the largest single catch made was but seventeen shad and many hauls were made when not a single shad was taken. Just above Perryville, Md., on the Susquehanna River, where for many years four seines have been operated and where years ago each seine took from 1500 to 3,000 shad per season, last spring less than 200 shad per seine were taken. The number taken in pound nets on these beds in recent years has not exceeded one-twelfth as many as were annually taken fifteen years ago. On these flats where, years ago, hundreds of men drifted nets for shad and where catches of 200 and even 300 shad per night were made, last spring not more than twenty men fished and they fished for shad only for a short period, for shad were so scarce on these natural spawning beds that fishing for them did not pay even at the exorbitant prices received. And this was true in spite of the fact that all of these men set from half a mile to more than a mile of net, as was done years ago when such large catches were made. Catches of twenty shad per mile of net were unusual and this at a time when the very largest catches should have been made. The average catches were less than half that number and frequently not a

single shad was taken in a night's fishing. Two experienced and successful fishermen, in the height of the season, in four successive nights succeeded in getting but one shad.

What does this mean? What can it mean but the rapid approach to the end of the shad industry in Chesapeake Bay?

Every living creature is subject to the laws of reproduction. Only in that way can life be perpetuated. This is just as true of shad as of any other form of life. It is so self evident and true that it seems there could be no need of light on the part of any one. Among the shad fishermen of Chesapeake Bay and its tributary rivers there is no clear, fixed uniformity of vision as to the cause of the unsatisfactory condition of the shad industry, which all recognize as unsatisfactory. All the fishermen, however, can roughly be placed in two groups. Each group holds fairly fixed opinions as to the cause of the scarcity of shad, but the views of these two groups—and they include all shad fishermen whether gill-net or pound-net men—are entirely antagonistic. Roughly, in one group can be placed all the men fishing regularly in brackish or salt water. In the other group may be placed all men fishing in the bay or tributaries above brackish water, or in other words, on the spawning beds of the shad.

When remedial measures are mentioned to the first group they almost invariably point to the fishing permitted on the spawning beds as the cause of the trouble. They say: "There's your trouble. Cut out the fishing up there. Let the shad alone on their spawning beds and they will become as plentiful as in years gone by." The above is fairly representative of the views of this group and it is simply surprising how positive many of the men are in giving expression to this view. Having given expression to the above, they speak of the catching of shad all ready to spawn as though it ought to be deemed criminal. They lose entire sight of the fact that every roe shad coming into the bay will reach, if let alone, the condition in which they so severely condemn taking them. They forget that the eggs in a shad are as surely lost when the fish is taken enroute to its spawning bed as when taken on the beds prior to its spawning.

Those belonging to the second group invariably point to the excessive fishing done farther down the river or bay as the cause of the trouble. They will tell you of the days gone by when ten

or twenty times as many men fished on the beds of the shad as at present and all caught fish. Then they point to the great increase in the number and amount of netting set for these fish farther down the bay. They will tell you that unless there is a limit put on the fishing farther down there will be no need to forbid catching shad on their spawning beds for only a few get up there now. Then they turn to the other side, the side of justice. "Why forbid us to catch a few shad for our families or for market, and that is all we are getting now, while every one in a position to fish farther down may use any net or device in getting shad?" But you say, "This is the spawning bed of the shad," and they answer by asking what possible difference that can make, and the writer is willing to confess that as applied to shad and some other forms of wild life that need not be mentioned here, he has never been able to answer that question in a way entirely satisfactory to himself.

The truth is, both groups fail to grasp the real cause of the trouble, although both groups see it as modified by selfish or personal interests. The cause is to be found in excessive fishing and the remedy in limitation. To be just, this must be applied to all. Even if the taking of shad is forbidden on their spawning beds it will not be effective in bringing about the desired result so long as no restriction is placed upon taking shad enroute to these beds, for the number now reaching the beds is entirely too small to restore the fishery to what it was years ago, or even to perpetuate their present numbers.

There are many men in Maryland, both in public and in private life, who see and see clearly what is needed to correct this unsatisfactory condition of the shad industry, and many of these men are giving their best thought and effort to finding a remedy, just as there are other men in other states working along the same line, but it is almost hopeless to expect uniform remedial action by the various states interested in time to save this industry. The work of these men is not to be discouraged. They deserve the co-operation and commendation of all, but the writer believes, as do many others, that the remedy is to be found in Federal action. Isn't there some definite or concrete way by which this Society can help in this movement for Federal action? Simply as a suggestion the question is asked: Would it be wise to appoint a permanent committee of members interested, coming

from states interested, to act as a head, or nucleus to all, whether members of this Society or not, who are interested in bringing about Federal action?

As the spawning beds of the shad and the channels through which they must pass to reach these beds are navigable waters, it seems certain that the Federal Government has authority to take action. The question arises, however, as to how far this action should go and along what lines? I believe this Society should take a definite stand on this question of the shad outlook with a view to bringing about uniform remedial state or Federal action. This is a question that is so pressing that its action should not be deferred. It is for this reason that I bring the matter to your attention. We all take pride in establishing new fish in our waters, but let us also take the same pride in the perpetuation of those which nature has placed there.

Discussion.

MR. MARSHAL MCLEAN, of New York: The Conservation Commission of New York is tremendously interested in the shad question. In years past the Hudson River was very valuable from this standpoint. But the shad fishing there, like those farther south, has dwindled away, probably due to two causes. At least one of these has been intensive fishing, without proper regard to reproduction; the other is the pollution of the river.

I am glad to say that most of these questions are now coming within the grasp of the proper authorities here in the state. Until last year the commission had authority only over the upper reaches of the river, as far down as Verplank's Point. Last winter the legislature placed the entire river under the jurisdiction of the commission. This means that nets had to be removed from the river from Friday night till Monday morning and the mouth of the river opened up during that time. Mr. Pratt has been making a study of the river and of the spawning beds and of the fishermen themselves, as described by the last speaker. The men who fished on the spawning beds complained of the men at the mouth of the river, and the men at the mouth of the river complained of the men fishing on the spawning beds. But now we have taken away the privilege of fishing from the mouth of the river during a certain period of each week. Perhaps for a week or two that is going to be extended still further to give the fish a chance to get up the river. Some of the fishermen themselves have recommended that certain areas of the spawning grounds on the upper reaches of the river be declared closed territory, and no fishing on it allowed. We hope to get some good results from that. If you close the door to these fish they cannot get in to reproduce, and if they cannot reproduce we are going to lose them. I think it would help the work enormously along the whole coast line if an association having the weight that this one has would take some affirmative action in regard to this matter.

MR. H. L. GIBBS, of North Carolina: This matter of the shad industry is one of great interest in our state. The value of the shad shipped from North Carolina is about three million dollars a year on an average. The bulk of the shad in North Carolina is taken from Pamlico and Albemarle Sounds; they come in at Hatteras and Oregon Inlets. Prior to this year most of the shad came in at Hatteras Inlet and up Albemarle Sound and the Roanoke River. This year they came in principally at Oregon Inlet and more shad were taken in that section of the state.

Now, speaking of federal control, I think that the government can co-operate in most of these phases of the fishing industry. I would like to suggest our idea about it. We have conservation laws in the state of North Carolina which I believe have been conceded by Secretary Redfield, who publicly stated this in his very able address in Wilmington in 1916, as being the best laws in any state in the Union, for conservation and the progress of the industry. In the year 1915, when the first general fish laws covering the whole state were passed, they provided, or rather established a commission. The first commission was composed of five men appointed by the governor, none of whom could have any financial interest in any fishing industry. This commission elected a commissioner who had general supervision over the fishing industries of the state, who made all other appointments. He was allowed two assistants by and with the consent of the commission. He appointed and the commission confirmed. The commission appoint their other help. The commissioner appoints his inspectors, he employs everything and does everything else pertaining to the industry. The commission's power and authority by this act was as follows: That the Fisheries Commission Board is hereby authorized to regulate, prohibit, or restrict in time, place, character and dimensions, the use of nets, so that this commission does not have to wait for the act of the legislature of the state if it's necessary to change the size of a net, or to say that you can fish in this place today and you shall not fish there tomorrow, for the benefit and for the good of the industry. It does not have to wait for the legislature to meet and change that statute, but the commission has the authority to say what size nets shall be used in that place, and what size shall be used in the other place, and at what particular place they may be used, and at what particular time they may be used. I am making these remarks because in the last address my attention was called to the fishing in Albemarle Sound.

The commission also has authority over the use of nets, appliances, apparatus and other means for killing fish, to regulate the seasons at which the various species of fish may be taken in the several waters of the state, and to prescribe the minimum size of fish which may be taken. The act of the legislature of 1917 amended that by making the purchaser or anybody else who had undersized fish in his possession subject to arrest and guilty of a misdemeanor, and the cases were heard by a superior court judge and not by a justice of the peace. Handling these violators has been a great deal of trouble with us, but by taking them before our superior court we have been able to enforce the law.

The first two years, 1916–1917, I tried ninety-six cases and prosecuted the majority of them myself, in the interest of saving of expense, because we are limited in revenue. Only two cases were lost out of the ninety-six. This year, or rather since 1917, the prosecutions have been a little over a hundred. I have had thirty-nine cases in one county of Bladen for the violation of the shad act and convicted all of them.

Now along the line of conservation, your legislatures should appoint commissions and give them proper authority. If the commission should find today that an act had been committed which was proper a year or a month or two before, but that it was necessary to stop it right away in the interest of conservation, and if they could meet together any day and do it, why, in such a way you can handle conservation. We have done it very successfully.

Now, referring to the Albemarle shad business, the government has a fish hatchery in our state, and it is a very nice thing for North Carolina. It has not been so very successful for the last two or three years, but I am satisfied that it will be in the future. The management, prompted by one or two local men right at that place, worked up some feeling against it. It was not intentional, but they just did not manipulate things properly, and they could not get the eggs they needed.

There was a law providing that on certain grounds in this sound, called the hatching grounds, the men should not set a net except between four o'clock and eleven o'clock in the afternoon, that being the time that the superintendent wanted the eggs for hatching. That was limited to the set net, stake nets or anchor gill nets. Pound nets set in the sound were allowed to stay all the time with no restrictions, so that the man who could only buy and furnish a little net and could not handle a pound net was limited in the time, by statute, when he could take the fish for a livelihood; whereas the other man was allowed to take them all the time, and that was what brought about the feeling. In order to allay that feeling and to help the hatchery achieve success the Board at a meeting in October of 1917, passed a rule which went into effect right away, because they had authority to do it, and this rule is bringing about now the good feeling which you will find existing between the hatchery and the fishermen in Albemarle Sound. They provided in that law that the fishermen could only set nets on certain days and at certain hours.

Now I have been down there recently, and the men say they will obey the rule. I tell them if they would not help this hatchery and carry out the rules, I will make it so they cannot fish on this ground at all.

The shad industry certainly, in my opinion, depends upon a closed season, and the work of the hatchery. We have a closed season after the 20th of May. The experiments in our waters indicate that not many shad are hatched, before about the 10th of May. It takes a certain temperature of water for a shad egg to hatch, and we do not have it before that time, and a shad that lays its egg before that time might as well be taken. And if we have a closed season from the 20th of May on, it shuts the hatchery down. We have no fears for the future of the shad industry of North Carolina.

I was asked by one fisherman on one occasion to go out with him, as he wished to show me something. I went out in the boat with him about two miles on the spawning ground where he had left a lid over a pound net. It was on the twentieth day of May of this year. After he had dropped his pound net, he raised the lid, and I saw thousands and thousands of little shad from the moss and from the accumulation around the nets, hiding there from other fish. So we found that this is another good idea on the spawning grounds. They are going to put lids out there hereafter until the shad fry get old enough to protect themselves. I make these remarks merely to show something of our conservation laws, of which we are very proud in North Carolina, and to indicate something about the prospects of the shad industry in Albemarle Sound.

MR. SNYDER: When I made those remarks I was not aware that North Carolina had placed any restriction on the nets in Albemarle Sound. Some years ago we wanted a restriction placed on those nets on the spawning beds. After they made the restriction and permitted the fishermen to set about three or four hundred yards of nets and stay there by them, we had the good will of everyone on the place. Prior to that, the fish hatchery got less than a million eggs a year from gillers, but after that we ran it up to over a hundred million eggs a year. The good will of the fishermen was obtained and every fisherman co-operated in getting eggs. Later, I am told, this good will was lost.

MR. WM. C. ADAMS, of Massachusetts: We have had the shad question and certain of these questions discussed year in and year out for a long time. We are willing to do almost anything in Massachusetts—to spend any reasonable amount of money—if we can get co-operation from those localities where shad, comparatively speaking, are reasonably abundant, to do something of a constructive sort to populate our waters again with this fish. In looking back over the efforts of all hands interested in the last few years, I have a feeling that we are working along the long distance lines that will accomplish this result. This brings up one phase of our work—not only of the American Fisheries Society, but the other allied societies—and it seems to me that we ought to lay out some kind of extended program that will involve four or five, or even more, years of constructive effort. When I say this I do not mean to reflect in any way on the efforts of the past, and especially on the constructive efforts of the Bureau of Fisheries as put forth, but there is a great chance here for interest and co-operation and for co-operation with the Bureau of Fisheries. If, in working out such a program, it seems advisable to make the Bureau of Fisheries an agent to bring this thing about, we should get more complete co-operation with the states interested in this program, and the Bureau of Fisheries, so that we can lay out a plan that will get us salutary results.

As far as Massachusetts is concerned, we have the money and we have the desire, and we will be glad to back up any agency that will take hold of this thing and work it out. I believe that this Society can be a tremendous factor in that work, but it must be along the line of a permanent program placed in the hands of responsible agents, with a systematic checking up to see that eventually we get the results.

A STUDY OF THE EFFECTS OF CERTAIN OILS, TARS, AND CREOSOTES UPON BROOK TROUT

(Salvelinus fontinalis.)*

By ADRIAN THOMAS,
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(From the Biological Laboratories of Clark University.†)

The era of the motor car has brought with it the demand for good roads. Woodblock, stone and asphalt streets are possible in our cities, but the cost of such materials is prohibitive of their use on suburban roads. Gravel alone does not wear well under the heavy traffic and it is necessary to find some material to aid in the building of good roads. Frequently tars and like substances have been employed in the treatment of gravel and macadam roads which improve their wearing qualities, and in many instances have proved to be satisfactory from the point of view of the highway-engineer and the motorist. Many heretofore waste products are being used as matrices in road construction and thus they attain commercial value.

Though many of these products seem to make good roads, complaints are often made by fishermen, and sportsmen too, that the tar from roads washes into streams and ponds during rains, thus killing the fish or driving them away. Several articles appear in the "Fishing Gazette" during the years 1912, '13 and '14, noting the scarcity of fish in certain streams and ponds, and attributing their absence to the toxic effect of road washings. While the fish themselves may not actually be killed by some of the tars, the larval forms upon which they feed are destroyed, thus forcing the fish to seek localities where they may find food.

Through the Office of Public Roads a number of samples of materials, used as "road binders" were obtained. Small amounts of these substances have been added to water in which trout were placed and the effects noted.

* The U. S. Bureau of Fisheries provided the funds for pursuing these experiments and this is published by permission of the Commissioner.

† The author wishes to thank Prof. R. S. Lillie, of Clark University, for placing at his disposal equipment for this investigation.

No difficulty was experienced in keeping the fish during experiments. Trout fingerlings* were used and during experiments were kept in battery jars containing 1500 cc. of water to which the substance in question had been added. The water was aerated by means of a constant stream of air being passed through it. The experiments were performed in an unheated room and in very cold weather freezing of the water was prevented by heating the air before passing it into the jars. The air supply was obtained by connecting a filter pump with a bottle having two outlet tubes, one extending to the bottom, through which the water was forced out, and one from the top through which the air was distributed to the jars. When necessary to heat the water the air was passed through another bottle in which there was an electrical heating unit, before admitting to the jars containing the fish. A thermoregulator was connected with the heating unit and placed in one of the jars which prevented the temperature exceeding 15° C. In control experiments where no tar was added to the water the the fish would remain in a perfectly healthy condition for weeks. The only disturbing influences were the products of metabolism, and growth of bacteria. These were eliminated by renewing the solutions once a week during cold weather, and after each feeding in warmer weather.

The trout were fed on chopped liver. Those in the tank where the stock was kept never refused food, but those in the jars to which some of the tars had been added refused food at times.

Some of the substances were extremely toxic to fish, others less so and some had no effect. The degree of toxicity seemed to depend, in most cases, largely upon the degree of solubility in water.

Following are some of the results obtained in experiments in which the samples sent from the Office of Public Roads were used. The description of the samples is that obtained from that office.

"No. 5899 consists of some of the higher boiling distillates of petroleum, flash point 148° C., burning point 178° C., presumably obtained from Indiana or Illinois crude petroleum."

* Through the courtesy of the Massachusetts State Fish and Game Commission, the trout were secured from the State Hatchery at Wilkinsville, Mass.

As much as 500 parts of the above oil added to 1,000,000 parts of water showed no effect upon the fish. The oil, however, emulsified with the water after the air had kept it in constant motion for several days. After this emulsification took place the fish refused to eat (about seven days). The fish would then die in a few days, partly because of lack of sufficient food, and more directly because the gill membranes became coated with the emulsion. If the solutions were not areated the oil would not emulsify and the fish lived well provided the water was changed often enough to insure sufficient oxygen.

"No. 5907 is a crude water-gas tar obtained from our local gas company. It is produced by decomposition of petroleum products for the enrichment of carbureted water-gas. This particular sample is free from water and consists of benzol, toluol, a small amount of naphthalene, and numerous other high-boiling hydrocarbons of the benzene series."

In a mixture of 66 parts of tar to 1,000,000 of water the fish began to dart immediately and showed irritation of the gill membranes. The following experiments may be cited to show the degree of toxicity of such a mixture:

EXPERIMENT 5907–1.

No. of fish: 1.

Used: 0.1 cc. tar No. 5907; 1500 cc. water. (*i. e.*, 66: 1,000,000).

Put in solution 10:12 A. M., October 23, 1914.

Fish began to dart at once showing irritation of gill membranes. Put in water containing no tar at 10:20 A. M. Began to revive by 10:30 A. M. Jumped out of jar but was replaced apparently uninjured. Began to swim normally by 11:30 A. M. Put back into tar solution at 5:00 P. M. Removed to water containing no tar at 5:05 P. M. Was at this time in same condition as at 10:20 A. M. By 5:20 P. M. no improvement was shown—nearly dead. Observed at 10:00 P. M. and found dead.

EXPERIMENT 5907–2.

No. of fish: 1.

Used: 0.02 cc. tar No. 5907; 1500 cc. water. (*i. e.*, 13.3: 1,000,000).

Put in solution 10:13 A. M., October 29, 1914.

Showed signs of irritation at once. 11:15 A. M., body showed faint pink coloration. Swimming on back 2:00 P. M. On back at bottom 3:00 P. M. Transferred to water containing no tar.

Put back in tar solution 9:15 A. M., October 30. Again removed to water containing no tar at 1:20 P. M. Continued to swim on back and dart occasionally. Put back in tar solution November 2, 5:00 P. M. Dead November 3, 6:00 P. M.

EXPERIMENT 5907–3.

No. of fish: 1.

Used: Trace* of tar No. 5907; 1500 cc. water.

Put in solution 5:37 P. M., March 2, 1915. March 13, solution renewed; fish sick. March 14, swimming on back, 1:00 P. M. March 15, 9:00 A. M., nearly dead. March 15, 6:00 P. M., dead. The fish showed signs of paralysis just prior to death.

"No. 5962 is said to be a product obtained as sludge in treating certain petroleum distillates with alkali after the sulphuric acid treatment. The sample shows 2.43 per cent of alkaline ash upon ignition. The presence of this alkali renders the material readily miscible with water in the form of an emulsion, although this emulsifying character is lost to some extent when the material has been exposed to the atmospheric influences for some time. The product is obtained in the refining of Texas petroleum."

Fish subjected to water to which traces of the tar had been added showed no effect after 19 days when the experiment was discontinued. 66 parts : 1,000,000 of water caused death in about 36 hours. 13 parts : 1,000,000 of water caused death in about three days.

"No. 6122 is said to have been produced by dissolving about 40 per cent oil asphalt in some high boiling petroleum distillate. It was presumably prepared from products obtained from Illinois crude petroleum."

66 parts : 1,000,000 of water caused death in about three days.

13 parts : 1,000,000 of water caused death in about three days.

Trace of tar had no effect in 19 days when the experiment was discontinued.

"No. 6550 is a Mexican crude petroleum having a flash point of 26° C., and a burning point of 53° C. It has a loss of 27.68 per cent in the standard volitization test and, through the loss of lighter materials contained in it, sets up quite rapidly when applied to a road surface."

* A trace of tar was obtained by dipping a match stem into the tar and then into the water. A thin, irridescent film on the surface could be seen.

As much as 265 parts : 1,000,000 of water did not affect the fish in thirty-two days.

666 parts : 1,000,000 of water showed no toxic action in ten days.

"No. 6979 is a refined coal-tar product as a residual after removing some of the lower boiling distillates from crude coal tar. It consists of a mixture of benzene hydrocarbons of various boiling points and yields practically no distillates under 170° C. It contains 14.6 per cent of organic matter insoluble in carbon disulphide."

66 parts : 1,000,000 caused death in less than twenty-four hours. Upon examination, the fish killed by this tar showed congestion of the intestines.

13.2 parts, or less : 1,000,000 of water did not affect the fish in thirteen days, after which the experiments were discontinued.

"No. 6980 is the crude coal tar from which No. 2979 was prepared. It was obtained in the manufacture of coal gas from bituminous coal in Salt Lake City."

330 parts : 1,000,000 of water caused death in seven hours.

100 parts : 1,000,000 of water was harmless after thirteen hours of exposure of the fish to this mixture.

"No. 7014 consists of a mixture of low-boiling distillates and semi-solid asphalt obtained from Texas petroleum. It has a flashpoint of 35° C., and burning point of 55° C."

165 parts : 1,000,000 of water was harmless in thirteen days.

"No. 7057 is an oil asphalt presumably prepared from a mixture of Texas and Mexican crude petroleum by distilling off the lighter components and possibly agitating the residue with air to some extent." (This product is a solid.)

6660 parts (by weight) : 1,000,000 of water proved non toxic.

"No. 7819 is produced from a crude material similar to No. 5907 by removing some of the lower-boiling constituents. This particular sample contains considerable napthalene."

66 parts : 1,000,000 of water caused death in three days.

33 parts : 1,000,000 of water caused death in ten days.

A trace appeared to be non toxic.

"No. 7058 consists of a mixture of Bermudez native asphalt with some form of petroleum flux." (This product is a solid.)

6660 parts (by weight) : 1,000,000 of water proved non toxic.

The crude oils and asphalts caused no toxic effect at all. In the case of the former no toxic substance is thought to be present, in the latter case the substance is in the form of a solid, insoluble mass. Gas house products were somewhat soluble and exceedingly toxic.

In many cases of road construction the gravel is spread, rolled, and the tar is then sprinkled over the surface by means of a sprinkling tank similar to those used for watering the streets. In many cases but little attention is paid to the condition of the ground or to the weather. The writer has seen roads being oiled during periods when rains were frequent and the roads were moist. Under these conditions of spreading, the tar has been noticed along the sides of the roads where it had been washed by the first rain after laying.

It has been observed that when roads are tarred during the course of construction, the tar being distributed throughout the whole bed and not only over the surface, and a thin layer of sand spread after the final treatment with tar, no appreciable amount washes away unless there is considerable rainfall during the first day or two after treatment.

A sample of concentrated waste sulphite liquor was obtained from the Office of Public Roads. It is obtained by concentrating the crude liquor obtained in the manufacture of paper pulp by the sulphite process. It is used quite extensively in the treatment of macadam and gravel roads. This sulphite liquor is freely soluble in water to which it gives a color varying from a light straw to a dark brown, depending upon the concentration.

Fish placed in solutions of 333 parts : 1,000,000 parts of water were not killed in two weeks yet at times they would show some signs of distress. Fish died within two weeks in solutions of 1333 parts : 1,000,000 of water. Though they did not show typical signs of poisoning, as the fish killed by other materials did, they were doubtless killed by this concentration of the waste. Some irregularity of the effect of the liquor upon fish in different experiments was noted. Marsh* has noted this and attributed it to individual variation.

*Marsh, M. C.; Effect of some Industrial Wastes on Fishes: The Potomac River Basin, Water-supply and Irrigation Paper No. 129, Government Printing Office, 1905.

Levy* notes that fish are reported to be affected by sulphite liquor wastes from paper mills. It is said that when the waste is emptied into streams, where fish are usually caught, the fish will not bite, but if the pollution is stopped for a period, good catches are made until the stream is again polluted. This Dr. Levy points out would tend to show that the fish were present all the time but refused to bite in the polluted water.

During the experiments it was noted that the fish would not feed in solutions of the sulphite liquor, but if taken from them and placed in pure water at intervals for a few minutes they would eat ravenously. Though this waste may not be termed toxic in the strictest sense, the fish certainly do not thrive in it. The evidence gathered shows that washings from roads treated with this substance, though they would not kill the fish perhaps, would tend to drive them to another locality free from pollution.

Water gas tar proved extremely toxic. A sample obtained from Providence, R. I., killed trout in thirty hours at a concentration of two and a half parts per million. In several cases the fish behaved not unlike they did in water to which creosote has been added. This behavior will be mentioned later.

A sample of light fuel oil was obtained from the Division of Fly and Mosquito Suppression of the Brookline, (Mass.), Board of Health. This oil is used to destroy and prevent mosquito larvæ in pools and the like. The oil was found to be non toxic. It emulsified upon aeration as did the sample of oil No. 5899 from the Office of Public Roads. After the oil had reached this state it coated the gill membranes. In experiments where the water was not aerated no emulsification took place and the fish appeared to be in a perfectly healthy state and would feed regularly. No signs of distress were shown at any time provided the water was renewed often enough to prevent asphyxiation.

Creosotes are used extensively as preservatives for wood that is to be immersed in water. Fishing nets are also "cured" at times by means of creosote. An article on "Net Curing by Creosote" appeared in the *Fish Trades Gazette*,† in which attention

* Levy, E. C.; Report to the Water Committee in the Investigation of the Effect of Trades Wastes on the Waters of the James River at Richmond, 1905.

† Fish Trades Gazette (London) vol. xxxl, No. 1606, Feb. 28th, 1914.

was called to the fact that fishermen in the vicinity of West Cornwall were in the habit of curing their nets by steeping them in creosote "green oil," and subsequently passing them through a wringing machine, thus leaving a minimum of oil. They were then dried for some weeks and then given two or three treatments with "cutch." After this treatment it is stated that no creosote could be detected. To quote: "Today, however, the treatment is vastly different, with very few exceptions; whole long trains of nets are shot out that have only a few days previously been taken out of barrels or other receptacles, in which they have been steeped in the "liquid," so that probably on the initial night of the season, with a fleet of sixty drifters casting out their trains, some hundreds of gallons of oil have been washed out, and has a tendency to permeate the water for some miles."

The flesh of fish caught in these nets would undoubtedly taste more or less of creosote, as this substance permeates very quickly, and the oil permeating the water would tend to drive the fish from the fishing grounds.

In the same article experiments conducted by J. E. Allen are cited. He found that the "green oil" at a dilution of one part per 1,000,000 parts of sea water would kill young swimming prawn, (heimysis) within an hour. An experiment is cited where twenty-five prawn were put in a solution of one part in 10,000,000 parts of sea water. Half were dead in twenty-five hours, three-fourths in two days, and all in five days. A control experiment showed no deaths at the end of six days.

Several samples of creosotes were obtained and small quantities of these added to water containing fish proved to be extremely toxic. The action of the creosotes on fish was very marked. In most cases when put into solutions of 13 parts per 1,000,000 of water the fish immediately began to dart violently. The gill movements were rapid at intervals, though at times the gill movements were abnormally slow. At other times the slow and rapid movements alternated for some time. In many cases the fish began to swim rapidly on their backs. At other times a gyratory movement was noticed.

Light and dark spots were noticed over the bodies. Ordinarily upon death the fish were of a fairly uniform color over the entire body, but when death was caused by very toxic solutions of

creosotes, dark spots covering half of the body were observed. In one or two cases the action of one or more fins was inhibited, and in general the nervous system appeared to be greatly affected. Fish in solutions of creosote would at times live for days with apparent loss of motor control. They would remain on their sides or backs practically motionless except for gill movements. At times the fish would quiver over the whole body, but were unable to swim or control their movements. When taken from solutions of the creosotes and put into pure water the fish would in many instances regain normal movements and to all appearances recover. The effect of the creosotes and like materials is so marked that behavior due to their presence cannot easily be mistaken.

The toxicity of creosote solutions may be seen from the following experiments in which fractional distillates of commercial creosote were used. One fish was used in each experiment.

FRACTION DISTILLING UP TO 205° C.

Exp.	Amounts Used		Concentration parts per million	Result
	Water	Creosote		
1	1500 cc	Trace	Trace	No effect in 21 days.
2	1500 cc	0.1 cc 1% solution*	0.6	No effect within 19 days.
3	1500 cc	0.02 cc	13.2	Died in 33 hours.
4	1500 cc	0.01 cc	6.6	Died in 21 hours.
5	1500 cc	0.05 cc	33.3	Died in one and two-thirds hrs.
6	1500 cc	0.05 cc	33.3	Creosote was put in water and aerated for four days before fish was put in. No toxic effect was noticed and the experiment was discontinued after seven days.

* A 1% solution was obtained by shaking 1 cc of the creosote with 99 cc of water.

FRACTION DISTILLING BETWEEN 205° C. AND 250° C.

Exp.	Amounts Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	Non toxic. After 11 days 0.02 cc creosote added. Gill movement became rapid. Dead in less than 12 hours.
2	1500 cc	0.02 cc	13.3	Helpless on back at bottom in 5 minutes. Half of solution poured off and an equal amount of water added. Fish Recovered.
3	1500 cc	0.1 cc 1% solution	0.6	Non toxic within 19 days.
4	1500 cc	0.01 cc	6.6	Solution changed every 7 days for 21 days. Fish sickened each time solution was renewed but recovered each time. Discontinued exp.
5	1500 cc	0.02 cc	13.2	Swimming on back after 3½ hours; recovered after about 24 hours. Discontinued after 5 days.
6	1500 cc	0.02 cc	13.2	Creosote put in water and aerated for 4 days before fish was put in. No effect noted within 11 days, when experiment was discontinued.

FRACTION DISTILLING BETWEEN 250° C. AND 295° C.

Exp.	Amounts Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	Non toxic. After 11 days 0.2 cc creosote added. Dead in 15 hours.
2	1500 cc	0.1 cc	66.6	Dead in six days.
3	1500 cc	0.1 cc 1% solution	0.6	Began to dart immediately, but recovered. Discontinued in 3 days.
4	1500 cc	0.02 cc	13.2	Showed distress in 3 hours. Recovered in 2 days. Discontinued after 5 days.
5	1500 cc	0.02 cc	13.2	Solution aerated for four days after creosote was added. Fish then put in. Swimming on back four hours. Recovered in two days. Discontinued after eleven days.

FRACTION DISTILLING BETWEEN 295° C. AND 320° C.

Exp.	Amounts Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	Non toxic. After 4 days 0.2 cc creosote added. Dead in 7 hours.*
2	1500 cc	0.01 cc	6.6	Dead in four days.
3	1500 cc	0.1 cc 1% solution	0.6	Dead in four days.
4	1500 cc	0.02 cc	13.2	Dead in 24 hours.
5	1500 cc	0.02 cc	13.2	Solution aerated for 4 days before fish was put in. No effect. Experiment discontinued after 11 days.

* Gills showed rapid movement at once.

RESIDUE AFTER DISTILLATION AT 320° C.

Exp.	Amount Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	Non toxic.
2	1500 cc	Trace	Trace	Non toxic. After 7 days 0.02 cc creosote added. Dead in about 12 hours.
3	1500 cc	0.1 cc 1% solution	0.6	Non toxic.
4	1500 cc	0.02 cc	13.2	Had shown no effect up to end of second day when fish escaped from jar.

COMMERCIAL CREOSOTE FROM FORREST PRODUCTS LABORATORY, MADISON, WIS.

Exp.	Amount Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	No effect in 7 days. 0.02 cc creosote added to water. Fish began to dart at once. Soon at bottom; motionless except for gill movement after a few hours. Recovered and swam freely in two days.
2	1500 cc	0.1 cc	66.6	Practically dead in three hrs.
3	1500 cc	0.1 cc 1% solution	0.6	No effect within 2 days after which fish escaped from jar.
4	1500 cc	0.4 cc	266.6	Dead in eight hours.
5	1500 cc	0.4 cc	266.6	Solution aerated for 4 days before fish was put in. Fish swam on back on second day. Somewhat recovered on 3rd day. Dead on 4th day.

CREOSOTE FROM COAL TAR.

Exp.	Amounts Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	No effect in 7 days. 0.02 cc creosote added to water. Began to dart immediately. Dead in 30 minutes.
2	1500 cc	0.01 cc	6.6	Darted occasionally; escaped in six days.
3	1500 cc	0.1 cc 1% solution	0.6	No effect within 19 days.
4	1500 cc	0.02 cc	13.2	Dead in about 40 min. Another fish put in same solution. Dead in 30 hours.
5	1500 cc	0.02 cc	13.2	Solution aerated for 4 days before fish was put in. Dead in 12 hours.

It can easily be seen that except when in mere traces most of the creosotes are highly toxic. In experiments where the water containing the creosotes was aerated for a few days before the fish were put into it, the fish lived much longer than when put in before aeration, thus showing that aeration had decreased the toxicity. When a second fish was put in a solution in which one had previously died, it would live longer than the first fish. This may have been because some of the creosotes had been absorbed by the fish first placed in the solution, thus the concentration reduced, or the toxicity may have been decreased by aeration. Fish from creosote solutions had a strong odor of the oil. The flesh even after being cooked, tasted of creosote.

To ascertain the effect on fish of wood after treatment with creosotes the following method was employed. Strips of wood about one square centimeter cross-section were painted with a thick coat of creosote and hung to dry in an unheated room for nineteen days. The temperature of the room, observed during the day, ranged from about 10° C. to about 20° C.

After drying, the strips of wood were anchored in jars of water, where they assumed a position not unlike that of spar-buoys. The anchors were made by sealing mercury in glass tubes. These were tied to the strips of wood by means of cotton cord. In this way no metal or other interfering substance was introduced into the water. The painted surface of the strips exposed to the water was about thirty or thirty-five square centimeters.

The strips were weighed before and after treatment with the creosote and also after drying. From two to five-tenths of a gram of the creosote adhered to each strip, depending upon the viscosity of the individual substance. From a half to an eighth of the weight of the creosotes was lost upon drying.

The strip treated with creosote from coal-tar killed the fish is about twenty hours. The one treated with the product distilling between 295° C. and 320° C., killed the fish in three days. The others produced no effect at all upon the fish in a week. The fish did not refuse food either.

A possible cause for the death of the fish in the two instances mentioned might have been that the creosotes had not thoroughly dried and hardened before the strips were immersed in water. Time did not permit repetition of the experiments.

The effect of aeration on the various substances used was not always the same. It would appear that the aeration increased the toxicity of crude oils. Sample No. 5899 as noted before did not appear to effect the fish because of its chemical nature, but after continued aeration emulsification occurred and the resulting emulsion then coated the gill membrane, preventing proper respiration. This, however, must be looked upon as merely a mechanical change, due to the constant agitation of the oil and water as the air passed through it. Comparatively large bubbles were employed in aeration as the outlets of the aeration apparatus were pinholes in the ends of glass tubes, thus the contents of the jars was constantly stirred.

In a few experiments in which the light fuel oil obtained from the Brookline, Mass., Board of Health, was employed; the water was not aerated, but changed as soon as the fish began to show any signs of insufficient oxygen supply. As has been before noted, the fish fed regularly and no signs of distress were shown. Controls, using fish of about the same weight, and employing the same volume of water having the same surface area exposed, showed that the oil-film caused little, if any, difference in the amount of oxygen absorbed from the atmosphere. The oil did not form a continuous film over the entire surface of the water, but had a tendency to form films at intervals, thus leaving considerable of the surface of the water directly in contact with the air.

It is very doubtful if, in the small amounts used in mosquito campaigns, the oil would effect the absorption of oxygen from the atmosphere by the water.

In cases of some of the creosote solutions, aeration decreased their toxicity. This is probably due to an oxidation of the oils themselves.

When tars, in drainage from roads, are carried into the streams, such drainage undergoes active aeration and agitation sufficient to cause emulsification of oils similar in nature to the crude oils used in the experiments. The small volume of such an emulsion entering a stream would scarcely be sufficient to affect the fish for the effect is undoubtedly a mechanical one in that the emulsion coats the gills and inhibits respiration, or else coats the food of the fish, causing them to ignore it. The emulsion being less dense than the water, would tend to be carried off on the surface in a

short space of time. It is believed that only the tars and oils which are of a toxic nature chemically would affect the fish when washed into streams by rains.

The problem of creosotes is chiefly to be met with where wood that is to be submerged in water, is treated with them; or where nets are so cured. It is thought that by allowing the wood to dry for a sufficient period before placing in water will greatly prevent detrimental results.

SUMMARY.

Products from gas works, and coal-tars containing substances somewhat soluble in water, were found to be exceedingly toxic to the fish. This is probably due to the fact that they contain some soluble substances, such as phenols and like compounds.

Crude oils and asphalts caused no toxic effect except that the crude oil would emulsify upon continued agitation and, if in the water in large proportions, finally coated the gill membranes of the fish thus inhibiting respiration. This is purely a mechanical effect, such as is unlikely to occur in streams or ponds.

The concentrated waste sulphite liquor, as obtained, did not kill the fish when added to the water in only small amounts, yet in these dilute solutions the fish would at times show signs of distress and were killed by higher concentrations. The results obtained tend to show that the presence of this material in natural water would cause the fish to seek an unpolluted locality.

Creosotes when added to water proved to be highly toxic. Aeration somewhat diminished the toxicity probably by the oxidation of the products themselves. In all but two cases wood treated with creosotes and then dried did not affect the fish, and in those two cases the toxicity has been greatly reduced by the exposure to air.

Discussion.

MR. W. E. BARBER, of Wisconsin: The Wisconsin Conservation Commission has had a great deal of trouble with paper mills discharging their wastes into the streams. We have an instance where a gas plant dumped its industrial wastes into the river. In the case of the gas plant, septic tanks were ordered put in. Those tanks were filled with gravel to half their depth, and all of the wastes from the plants were deposited in them. There was an outlet from one tank into the other, and then it led to the river. After those tanks were put in under proper construction we had no further difficulty with the gas company. But with the paper mills we have had untold difficulty. We found that some of the plants deposited all of their industrial wastes into the river—the wood pulp, the bark, and all of the refuse. There are sixteen plants located on one river in a distance of about 150 miles, and it is driving the fish entirely out of that river, as you all must well know. They are ordered to put in filtration plants. The waste is to be filtered through coke, and from that into two septic tanks, and from that drained into the river, all of the heavy wastes to be returned to the plants and used for fuel. The paper mills are only too glad to co-operate with the officers in constructing the necessary equipment for taking care of their wastes.

Another difficulty we have had is with the pea canning plants, of which there is a great number in the state. The seepage from these which is very poisonous, has been draining into some of the trout streams. Tanks to take care of all of the poisonous matter have been ordered, and this has been conformed to by practically all of the plants of our state that have been depositing their waste in the streams. The difficulties that we have had with the paper mills have arisen mostly because we have had no law in the state until last year prohibiting the deposition of their industrial wastes in the streams.

The paper mills thus encounter an expense of about $2500 to $3000, but they are all very willing to co-operate, as I said, and we believe that if other states are having the same difficulty—and no doubt some of them are—this system will remedy the situation.

PROFESSOR E. E. PRINCE, of Ottawa, Canada: Mr. Chairman, I have taken a great interest in this paper, because in Canada we have had a number of tests made, and we were rather disappointed to find that in many cases the refuse brought into the rivers did not prove fatal to the fish. I have no doubt it affected feeding conditions, but we found very rarely that the fish died from the poisons from gas works, etc., doubtless due to the fact that rapid oxidation took place in the rapid running water. But the point I want to emphasize is this, that undoubtedly polluted water, in the case of salmon, will turn away fish. I have had a particular case before me as Commissioner of Fisheries in Canada, lately in North New Brunswick. A certain river has for a season or two showed very serious deterioration. The fish undoubtedly came to the mouth of the river, turned about there, and evidently were deterred on account of the amount of wastes which has

been poured in within a few miles up the river. The only explanation has been that the fish have been turned away, because they have appeared very universally in neighboring rivers. Instead of going into their own river, they were turned away by the flavor of the water, as it were.

MR. THOMAS: I am very glad indeed to hear what Doctor Prince has to say. Having investigated nearly a dozen cases in the state of Virginia during the past year, I received reports, each time before I made the investigation, that thousands of fish had been killed by a certain pollution, but only in one instance did I find any evidence of fish having been killed. It seems they are simply driven away, and seek other localities. Fish above the source of pollution are as numerous as ever, and some miles below the source of pollution fish begin to show up, according to the amount of pollution which is poured into the water, and they increase as you go further down stream. In only one case have I noticed recently where any number of fish were killed, and that was from a furnace and iron works where the fuel gases were washed before being used as fuel. These gases contained prussic acid, and I found as much as thirty parts per minim of prussic acid in the water which was sent into the stream. Of course that did kill the fish, and very quickly, inside of forty-eight hours after the furnace was started. We have had no fish in that stream since, but are taking every step to prevent any more prussic acid being poured into the water; but that is the only instance that has come to my attention where any great number of fish have been actually killed by pollution.

DR. R. C. OSBURN, of Ohio State University: I wish to ask Mr. Thomas if, in the course of his experiments, he has noticed any difference in the toxic effect of these substances at different temperatures. It occurred to me when Dr. Prince was speaking that possibly the lack of effect, or slight effect, which he noticed might be due to the lower temperature of the water in Canada, as we know that many substances have less effect at lower temperatures.

MR. THOMAS: I have not sufficient data to publish it, but my investigations showed that with higher temperatures, tars and creosotes affected the fish much more readily. I am almost forced to believe that it is due to the solubility of these substances in the water at higher temperatures. With oils undoubtedly the temperature has considerable to do with toxicity. I tried to run these experiments with a variation of five or ten degrees. I have not had an opportunity to continue the study with reference to temperature changes, but preliminary experiments show that undoubtedly the temperature is a great factor in producing a toxic effect. In cases of ordinary pollution I do not believe that the temperature would have very much effect.

MR. W. E. BARBER, of Wisconsin: It seems that we have a proper diagnosis of the disease, and now what we want is an absolute remedy for this pollution. We have discovered that where the deposits from the pea canneries enter our rivers and streams the fish are killed. The paper waste seems to drive them away. We do not find dead fish, but there are no fish

there to be caught. What we want is to know just what ought to be done as a remedy.

(In reply to questions by Mr. Titcomb and Mr. O'Malley, Mr. Barber replied that the Wisconsin law absolutely compelled the paper factories to keep poisonous wastes out of the streams and that the system of prevention is just being installed this year.)

MR. G. C. LEACH: Sometimes deleterious substances are turned into the streams inadvertently. For instance, out through the west, where they have so many stamping mills, cyanide is used and sometimes it will moisten the tank and get into the streams. Of course it usually kills all the fish in the immediate neighborhood until it passes down the stream and becomes diluted, and it is not always through the fault of the companies having the plants.

MR. M. L. ALEXANDER, of Louisiana: We have been giving this matter some attention down south, and have ample law, as far as that is concerned, to cover it. The large paper mills recently erected there, costing several millions of dollars, take ingredients out of pine trees. The matter that comes from those mills has discolored the water very much, but I found that it has not killed the fish, nor affected it for drinking water for stock. However, we have had these people run their water as far as possible out into the streams and across the sand bars, to give it a filtration process.

Another large industry down there is the distillation of pine stumps, a sort of alcoholic distillation that seems to be very poisonous indeed. The particular factory that I investigated has poisoned the stream on which it is located for about twenty-five miles, and the water was even poisonous to stock—a very serious problem. I had the manager come down from New York, and they are now trying to perfect some system that will correct this, though it will cost them a good deal of money.

The most serious trouble, however, that we have on our bayous and streams in that low country is the poisonous matter that comes from the sugar refineries. The manufacture of sugar is one of our greatest industries, and great numbers of these refineries are located along the bayous and streams, and during the period of their operation they unquestionably kill the fish through the acids that come from the waste matter from those mills. We have made a general survey of the situation and have tried as far as possible to run this matter off through the swamps, but it comes back into the streams.

We have absolute authority under the law to close down these factories that poison the streams, but to close them down would mean the destruction of the entire sugar crop that has to be harvested in a very short space of time, about fifty days. If we put these drastic laws into effect it will destroy the crop of sugar, which the Government particularly needs at this time. Louisiana is producing 85% of the cane sugar of the United States. We cannot do it, so we have to let them kill some of the fish.